Volume 21, Number 9 May 15, 1967

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 14216, 14447, 14699, and 14795.

14144 (AERE-R-5329) IMPROVEMENTS IN THE DETERMINATION OF NITROGEN IN PLUTONIUM MONONITRIDE AND URANIUM HIGHER NITRIDES BY CHEMICAL METHODS. Milner, G. W. C.; Jones, I. G. (Atomic Energy Research Establishment, Harwell (England)). Nov. 1966. 25p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. HMSO 3s. 6d.

In an improved Kjeldahl method for plutonium mononitride the sample is transferred directly to the flask of the distillation apparatus by means of an aluminium sachet, which is allowed to dissolve in sodium hydroxide solution. Ammonia produced from the nitride sample is removed with argon. Analysis of a sample can be completed in under 30 minutes. The coefficient of variation for the determination is better than 0.5%. The dissolution of higher uranium nitrides in mineral acids was improved by heating overnight at 195°C in a sealed Pyrex tube. For samples up to $UN_{1.5}$ concentrated hydrochloric acid is employed, whereas a mixture of this acid with 5% hydrofluoric acid is used for those with compositions of $UN_{1.5}$ and higher. The sample solution is transferred to sodium hydroxide in the Kjeldahl distillation flask and the determination is completed as for plutonium mononitride. Results by this method are in fair agreement with those obtained by the Dumas and inert gas fusion methods of analysis. The coefficient of variation for a determination is better than 0.9%. (auth)

14145 (CEA-R-3082) DETERMINATION DE L'URANIUM CONTENU DANS DES EFFLUENTS D'USINE DE TRAITEMENT DE MINERAIS. (Determination of the Uranium Content in Treatment Plant Effluents). Bourseau, Roland; Fabre, Pierre; Zini, Edmond (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Nov. 1966. 24p. (In French). Dep. mn.

A process is reviewed for detecting traces of uranium in solution and, more particularly, in effluents from uranium ore chemical treatment plants, which are collected after extraction by TBP or at the discharge end of ion-exchange columns. The uranium content of the solution is determined by measuring gamma rays emitted by the uranium. In order to get rid of the errors likely to be caused by the radioactive disequilibrium of the solution, the radioactive daughter products of uranium, together, if need be, with those of thorium-232 are removed by means of coprecipitation with a fluoride or phosphate formed within the solution. Thus it becomes possible, after filtration, to carry out a measurement of gamma radiation given off by the uranium remaining in solution. (auth)

14146 (GAT-T-1470) ANALYSES OF IMPURITIES IN URANIUM COMPOUNDS BY ATOMIC ABSORPTION. Walker, C. R.; Vita, O. A. (Goodyear Atomic Corp., Piketon, Ohio). Mar. 7, 1967. Contract AT(33-2)-1. 4p. (CONF-670308-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 18th Conference on Analytical Chemistry and Spectroscopy, Pittsburgh, Pa.

A method is described for the microdetermination of twelve elements in uranium and uranium compounds by atomic absorption spectroscopy. These elements are aluminum, cadmium, calcium, chromium, cobalt, copper, iron, magnesium, manganese, nickel, lead, and zinc. A sample is dissolved in 6 to 8N nitric acid, from which the uranium is selectively removed by a single extraction with tributyl phosphate. The aqueous layer is evaporated to dryness and the residue redissolved in 0.2N hydrochloric acid. Any or all of the elements can then be determined in this one solution by atomic absorption spectroscopy. The limits of error of the analyses are less than 10%, which compares favorably with colorimetric procedures and is better than emission spectroscopy. (auth)

14147 (LYCEN-6642) ANALYSE DES COURBES DE DECROISSANCE RADIOACTIVE. (Analysis of Radioactive Decay Curves). Couchoud, Sylvia (Lyon Univ. (France). Institut de Physique Nucleaire). Sept. 1966. 58p. (In French). Dep. mn. Thesis.

The feasibility of analyzing radioactive decay curves for samples with an unlimited number of elements with no other knowledge than the counting rate as a function of time using a very small computer is reported. The procedure consists of two steps: first a qualitative analysis and then a quantitative analysis. Qualitative analysis is made with the aid of a 5-step program. The number of elements and approximately their periods are found. If the half-lives are not precise enough to permit a definition of the nature of the elements, these are adjusted with the aid of the fourth program or, if the intervals of counting time are constant, with the second and third program. When the number and nature of the elements are determined, the values thus obtained are replaced by more precise ones. The FORTRAN program for the analysis is given. (J.S.R.)

14148 (N-66-36063) ABUNDANCES OF TRACE ELEMENTS Na, Sc, Cr, Mn, Fe, Co, AND Cu IN CHONDRULES AND METEORITES; IN METEORITES AND TERRESTRIAL MATTER; AND U IN TYPE I CARBONACEOUS CHONDRITES. Quarterly Progress Report, March 1–June 15, 1966. Schmitt, R. A. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). July 15, 1966. Contract NASw-843. 41p. (NASA-CR-77809). CFSTI $3.00 cy, $0.65 mn.

Abundances of the elements Na, Sc, Cr, Mn, Fe, Co, and Cu in 20 individual chondrules separated from the unequilibrated Weston chondrite, and 20 individual chondrules from the unequilibrated Tennasilm chondrite, were determined by instrumental neutron activation analysis (NAA). The abundance data obtained are tabulated. Data are also given for radiochemical NAA in which the indium abundances in some 12 meteorites and 10 terrestrial specimens were investigated. These data supplement indium abundance data in samples of meteorites and terrestrial specimens previously determined. The abundances are also compared with other major elements in the third group of the periodic table. In addition, the abundance of U in two different Type 1 carbonaceous chondrites, Orgueil and Ivuna, was determined by radiochemical NAA. The experimental details are given, and the results of the beta and gamma counting are tabulated and discussed. (STAR)

14149 (ORO-3106-21) SPECIAL GAS CHROMATOGRAPH FOR USE IN GAS PHASE RADIATION CHEMISTRY. Heckel, Edgar; Hanrahan, Robert J. (Florida Univ., Gainesville. Dept. of Chemistry). Apr. 1967. Contract AT(40-1)-3106. 5p. (CONF-670401-6). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For Presentation at 153rd National Meeting, American Chemical Society, Miami Beach, Fla.

A special gas chromatograph was constructed for the analysis of products formed during the radiolysis of gas mixtures. The apparatus consists of two independent chromatographic units connected only through the common sample inlet system. The sample inlet system consists of two sampling loops, a part for attaching the sample, a part for removing a gas aliquot for external analysis (fluoride ion), and an automatic Toepler pump which is the heart of the system. The entire inlet system can be evacuated

by a two-stage rotary vacuum pump when all valves are in the proper positions. (P.C.H.)

14150 (UCLA-12-613) SOLUBILIZATION METHOD FOR CENTI-GRAM TO KILO-GRAM PLANT SAMPLES. Wood, R. A.; Wakakuwa, S. T.; Rutherford, T. H. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). Jan. 1967. Contract AT(04-1)-Gen-12. 11p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A method is described for the solubilization of 100 to 1000 gram plant samples prior to the sequential separation and quantitative determination of ^{90}Sr, ^{144}Ce, ^{144}Pr, ^{137}Cs, and the stable elements Sr, Ca, P, K, and Ba. Radioexchange and solubilization are initiated by refluxing the partially oxidized (dry-ashed) sample with concentrated nitric acid followed by neutralization, and the dropwise addition of 30% hydrogen peroxide. After the solution becomes light amber to yellow in color, any residue present is collected by filtration and separately solubilized using hydrofluoric and concentrated nitric acid. The solubilized residue is recombined with the original sample, the hydrogen peroxide treatment is continued at a pH 5 to 6 for 2 hr or until the sample becomes aqueous clear. Using this method the solubilization time was reduced from a minimum of 7 to 2 days. (auth)

14151 (USNRDL-TR-67-3) LEAST SQUARES ANALYSIS OF TIME-DEPENDENT GAMMA-RAY PULSE HEIGHT SPECTRA. Yamamoto, S. (Naval Radiological Defense Lab., San Francisco, Calif.). Oct. 11, 1966. 27p.

A computer method is described for estimating radionuclide abundances in a mixture by least squares analysis of a time-dependent set of gamma-ray pulse-height spectra. The pulse-height distributions and decay constants of the constituent radionuclides are used as known input information. The method was programmed for the computer and the program was tested by analyzing spectra of mixtures of ^{103}Ru and ^{106}Ru of known compositions, whose ^{103}Ru fractions varied from 10 to 90%. The mixture compositions were determined by this program with an accuracy of better than 2% of the actual amount, and in most cases better than 1%. (auth)

14152 AUTORADIOGRAPHY OF RADIOACTIVE THIN-LAYER CHROMATOGRAMS. Jack, R. Cecil M.; Smith, W. G. Jr. (Boyce Thompson Inst. for Plant Research, Inc., Yonkers, N. Y.). Contrib. Boyce Thompson Inst., 23: 215-17(Jan.-Mar. 1966).

A casette permitting the exposure of x-ray film to radioactive components on thin-layer chromatoplates is described. The casette consists of two oak frames, both of which are covered on the outside by $^3/_8$ in. plywood. The plywood is mortised into the frames. The frames are joined together by piano hinges thereby forming a box. When the box is closed, it becomes light-tight because of tight-fitting tongue and groove. When opened, a central recessed space of 8 × 10 in. is available to accommodate a standard 8 × 8 in. chromatoplate. The casette can be kept in the lab in the light after it is loaded with film; wrapping it in paper is unnecessary. Five features of the casette simplify its use: the ease of inserting and removing the chromatoplate, the ease and reproducibility of inserting film of standard size, the ease of inserting film in complete darkness if necessary, the applicability of layers of different thicknesses by insertion or removal of cardboard on the film, and the adaptability to plates that are slightly smaller than average without danger of plate movement after the film is inserted. (BBB)

14153 THIN-LAYER CHROMATOGRAPHY RADIOASSAY: A REVIEW. Snyder, Fred (Oak Ridge Associated Universities, Tenn.). Atomlight, No. 58, 1-16(Feb. 1967).

Autoradiography, fluorography, strip scanning, zonal scanning, and elution procedures are used for radiometric analysis of thin-layer chromatograms. Thin-layer chromatographic profiles of ^{14}C and ^3H determined by liquid scintillation zonal scans are superior to other methods in sensitivity and resolution. Recently the entire zonal-scan procedure was computerized so that the distribution of the chemical mass or radioactivity along a chromatographic lane can be graphed by an electroplotter directed by the TLC computer program. The program gives a direct print-out of area percent, recovery, and counting efficiency. Corroborative TLC (argentation and borate) and gas-liquid chromatography techniques are described for the separation of glyceryl alkyl ethers according to unsaturation, isomeric form, and chain length. (auth)

14154 METHODS OF ASSESSING FALLOUT. Hamada, Gerald H.; Kruger, Paul (Hazleton-Nuclear Science Corp., Palo Alto, Calif.). pp 287-305 of Radioactive Fallout, Soils, Plants, Foods, Man. Fowler, Eric B. (ed.). Amsterdam, Elsevier, 1965.

A review (51 references) is provided of radiochemical procedures for measuring fallout radionuclides in various materials. Samples taken for fallout studies include air particulates, rain and sea waters, soils, vegetations, foods, and animal and human bones and tissues. Since soils and vegetation represent the more complex chemical and physical systems of these types, the problems of radiochemical preparation for soils and vegetation are reviewed in detail. These problems include the precautions necessary for adequate and representative sampling, pretreatment of samples, if necessary, chemical or physical preparations for radioactivity measurements, and choice of analytical methods for specific radiations or radionuclides. Also considered are some precautions necessary in sampling and pretreatment, and the possible pitfalls that may be encountered in the analysis. (BBB)

14155 NEW METHOD FOR THE DETERMINATION OF RADIOSTRONTIUM IN URINE. Eakins, J. D.; Gomm, P. J. (Atomic Energy Research Establishment, Harwell, Eng.). Health Phys., 12: 1557-63(Nov. 1966). (AERE-R-4753).

A new method for the determination of radiostrontium in urine is described. After the addition of strontium carrier to 300 ml of urine, a single precipitation of strontium sulfate is carried out in the presence of EDTA at a controlled pH. This gives a good separation from calcium and avoids the use of fuming nitric acid employed in the more usual method. The subsequent separation of strontium from barium is also discussed and an improved method of separation described. The full procedure is considerably quicker and more convenient than the current one and compares favorably with other published methods. If additional sensitivity is required, a modification of the procedure is available for the analysis of 1500-ml urine samples. Overall recoveries of about 80 per cent are obtained. The calcium content of the separated strontium carrier is about 1 per cent for 300-ml samples and less than 2 per cent for the larger samples. (auth)

14156 SOLVENT EXTRACTION AND SPECTROPHOTOMETRIC DETERMINATION OF MOLYBDENUM(VI) WITH TRI-n-BUTYL PHOSPHATE. Dhara, S. C.; Khopkar, Shripad M. (Indian Inst. of Tech., Bombay). Indian J. Chem., 5: 12-13(Jan. 1967).

A method is described for the rapid and quantitative extraction of Mo(VI) from solutions containing 4M lithium chloride and 6M hydrochloric acid by 20% TBP and its direct spectrophotometric determination in the organic phase as the orange-colored thiocyanate complex at 465 mμ. The extractable species probably has the composition $MoO_2Cl_2 \cdot 2TBP$. Common cations, viz. Cd, Sb, Sn, Fe, Cr, Zn, U, Zr, Ba and Sr, and tungstate commonly associated with Mo(VI) in the fission products do not interfere in the determination even if present in the ratio of 1:5. The proposed method is selective and permits separation and direct determination of Mo(VI) in alloy steel. (auth)

14157 DETERMINATION OF SELENIUM IN STANDARD ROCKS BY NEUTRON ACTIVATION ANALYSIS. Brunfelt, A. O. (Oslo Univ.); Steinnes, E. Geochim. Cosmochim. Acta, 31: 283-5(Feb. 1967).

Selenium concentrations in terrestrial rocks were determined by distillation with HCl/HB+ as a specific separation method, followed by neutron activation analysis based on 120d ^{75}Se. The mean values given are probably accurate to ±10% for concentrations above 0.02 ppM and to ±20% for lower concentrations. The sensitivity for detection of Se is 0.0005 μg. (INIS-UK)

14158 THE INFLUENCE OF EDTA AND DTPA PRESENT IN URINE SAMPLES ON THE ALKALINE PHOSPHATE PRECIPITATION. Valentin, N. (CEN, Mol, Belg.). Health Phys., 12: 1633-5(Nov. 1966).

Results of an alkaline phosphate precipitation method for plutonium recovery from urine containing EDTA or DTPA in varying amounts are given in tabular form. (C.O.)

14159 ^{125}Sb CONTAMINATION IN ANTIMONIAL LEAD. Rundo, J. (Atomic Energy Research Establishment, Harwell, Eng.). Nature, 213: 796(Feb. 25, 1967).

The presence of ^{125}Sb (half-life 2.78 years) in newly manufactured antimonial lead was confirmed. Experimental details are outlined. Concentrations of ^{125}Sb were estimated as approximately 3.6×10^{-14} Ci/g of lead, or 0.9×10^{-12} Ci/g of antimony. The origin of the contamination is unknown. Fall-out might be a possible source. (UK)

14160 THE DETERMINATION OF ANTIMONY, CADMIUM, CERIUM, IRIDIUM, AND SILVER IN BIOLOGICAL MATERIAL BY RADIOACTIVATION. Bowen, H. J. M. (Univ. of Reading, Eng.). Analyst, 92: 118-23(Feb. 1967).

A method for determining antimony, cadmium, cerium, iridium, and silver simultaneously in a sample of biological material is described. The method involves radioactivation to long-lived radionuclides by using thermal neutrons from a reactor, and has a high sensitivity. (auth)

14161 RADIOACTIVELY LABELLED COMPOUNDS. PART IV. THE PAPER BLANK VALUE AS A DISTURBING FACTOR FOR THE QUANTITATIVE DETERMINATION OF REDUCING SUBSTANCES BY MEANS OF TETRAZOLIUM SALTS ON CHROMATOGRAPHIC PAPER. Hartrodt, Walter (Institut fuer Kortiko-Viszerale Pathologie und Therapie, Berlin). J. Chromatogr., 26: 151-7(Jan. 1967). (In German).

The micro-determination of reducing substances with tetrazolium salts on paper chromatograms is of advantage especially for radioactive tetrazolium salts. However, the paper blank value may considerably impede the analysis of the produced formazans. While the excess tetrazolium salt is satisfactorily eluted (below 1%) with 2% acetic acid, the unspecific reducing substances of chromatography papers form the main part of the paper blank value. The lower paper blank values are obtained by pretreating SS 2043a and SS 2043b (acid washed) with methanol/KOH, and by having as short a reaction time and as low an alkalinity of the tetrazolium salt solution as possible. The experiments were conducted with ^{131}I-labeled triphenyltetrazolium chloride (^{131}ITTC) and the radioactivity of the ^{131}I-formazan was measured directly on the chromatography paper. (auth)

14162 A COLUMN-SWITCHING TECHNIQUE FOR THE ANALYSIS OF MIXTURES OF FLUOROCARBONS LABELLED WITH A SHORT-LIVED ISOTOPE. Todd, J. F. J. (Univ. of Kent, Canterbury, Eng.). J. Chromatogr., 26: 273-5(Jan. 1967).

The separation and assay of a series of mixtures of $CF_3{}^{18}F$, $CH_3{}^{18}F$, $C_2H_3{}^{18}F$, and $CF_2{}^{18}FI$ was investigated. Since the samples were in trace amounts and had relatively short half-lives, a quick analysis was required. A column combination of 8-m silicone oil column (25°C) coupled in series with a similar 5-m hexamethylphosphoramide (HMP)/firebrick column operating at 0°C proved successful in separating the components, however, the trace quantities of CF_3I present in the mixture were irreversibly adsorbed on the latter column. A column-switching apparatus is described that proved capable of avoiding this drawback. (D.H.M.)

14163 A NEW METHOD FOR ASSAY OF RADIOACTIVE DIMETHYL SULFOXIDE AND ITS METABOLITE, DIMETHYL SULFONE. Hucker, H. B.; Hoffman, E. A. (Merck Inst. for Therapeutic Research, West Point, Pa.). Experientia, 22: 855-6(Dec. 15, 1966).

A quick and accurate method was developed for estimating dimethyl sulfoxide (DMSO) and its metabolite dimethyl sulfone ($DMSO_2$) in radioactive solutions using $SnCl_4$ precipitation and gas chromatography. The method may also be applicable to solutions containing other labeled compounds, provided these are not precipitated by $SnCl_4$. (P.C.S.)

14164 DETERMINATION OF THE DEUTERIUM CONTENT OF NATURAL WATERS IN U.A.R. BY MASS SPECTROMETRY. Hallaba, E.; Hamza, M. S. (Nuclear Chemistry Dept., Cairo). Isotopenpraxis, 2: 458-61(Dec. 1966).

Deuterium content of natural waters was estimated with a mass spectrometer using different methods of reduction of water samples. The optimum conditions for isotopic analysis were found, and the different parameters of the instrument were obtained. The accuracy was within ±3 ppM. (auth)

14165 CONTRIBUTIONS TO THE BASIC PROBLEMS OF COMPLEXOMETRY. XXII. DETERMINATION OF THORIUM AND SCANDIUM IN THE PRESENCE OF EACH OTHER. Pribil, R.; Vesely, V.; Horacek, J. (Heyrovsky Polarographic Inst., Prague). Talanta, 14: 266-8(Feb. 1967)

A method for the determination of thorium and scandium in the presence of each other is presented. Two aliquots of the solution are necessary. In one the sum of thorium and scandium was determined by direct titration with DCTA (1,2-diaminocyclohexanetetraacetic acid). In the second, the thorium and scandium were treated with an excess of TTHA (triethylenetetraminehexaacetic acid), phosphate was added, and zinc was used to titrate the excess of TTHA and to displace the scandium from its TTHA complex. (auth)

14166 ANALYSIS WITH THE AID OF RADIOACTIVE REAGENTS. II. Lerch, P. (Institut de Radiophysique Appliquee, Lausanne, Switzerland). Microtecnic, 20: 633-5(Dec. 1966)

The use of radioactive reagents in chemical analysis is reviewed. Applications included are the determination of SO_4^{2-} ions using radioleads; determination of CrO_4^{2-}, VO_3^-, and MoO_4^{2-} ions using ^{110}Ag; determination of Mg^{2+} using $^{32}P_i$; radiometric titration of iodides using ^{131}I; complexometric titration of the amino acids that complex copper using ^{64}Cu-labeled copper phosphate; and determination of oxygen dissolved in water using dissolution of a labeled metal. Titrating procedures using radioactive reagents; radiocoulometric analyses, radioactive precipitates on membranes, and radiolabeled amalgams are discussed. (D.H.M.)

14167 OXYGEN AND CARBON CONTENT OF LANTHANIDE AND ACTINIDE METALS OBTAINED BY REDUCTION OF "WET" AND "DRY" PRODUCED TRIFLUORIDES. Ryan, V. A.; Green, J. L.; Lowenhaupt, E. H. (Univ. of Wyoming, Laramie). J. Inorg. Nucl. Chem., 29: 581-4(Feb. 1967).

The analysis for oxygen and carbon of small samples of lanthanide and actinide metals prepared by reduction of the trifluorides with, say, barium vapour is considered. The analysis of sub-milligram samples for common anionic impurities was not feasible until the development of activation analysis with ^{3}He ions as bombarding particles. This technique was modified for work with active metals. The activated targets were counted using pulse height analysis or coincidence counting of gammas from positron annihilation. Analysis for oxygen content was based on the $^{16}O(^3He,p)^{18}F$ transformation and for carbon on $^{12}C(^3He,\alpha)^{11}C$. ^{18}F is a positron emitter with half-life of 110 min, while ^{11}C similarly decays with a half-life of 20.5 min. The difference in half-life is sufficient to allow straightforward decomposition of the annihilation-gamma decay curve into oxygen and carbon components. Details of the experimental techniques adopted are given. Results are tabulated for terbium, americium, and curium metals. It was found that considerable amounts of oxygen remain in "wet-precipitated" terbium trifluoride even after extended periods of drying over P_2O_5 or in high vacuum (terbium was selected for study because the reduction conditions are similar to those used for curium). On the assumption that most of the oxygen originated from water or oxyfluoride, studies were made with "wet-precipitated" terbium trifluoride treated with anhydrous HF. The oxygen content of metal produced from this material was substantially lower than when using physically dried trifluoride; carbon contents, however, were rather high. Treatment with BrF_3 gave inferior results. The HF method resulted in metal samples with oxygen contents of 300 to 700 ppM and carbon contents of 250 to 600 ppM. (UK)

14168 ANALYTICAL METHODS BASED ON REFLECTION AND ABSORPTION OF RADIOACTIVE RADIATION. IV. EVALUATION OF PROCESS CONTROL APPLICATION OF THE RADIOMETRIC METHOD IN TECHNICAL CONTROL OF CONTRAST MATERIALS. Schiller, P.; Synek, J. (Komenskeho Univ., Bratislava). Cesk. Farm., 15: 508-9(Nov. 1966). (In Czech).

A nondestructive radiometric method is described for determination of iodine concentrations below a specified minimum or above a set maximum. The method employs reflection of radioactive rays. The analysis is completed in 10 min as compared to a chemical analysis employing wet decomposition of the substance and argentometric determination using potentiometric indication, which requires 1½ to 3 hr. (TSS)

14169 THE USE OF TRITIATED WATER, 4-AMINOANTIPYRENE, AND N-ACETYL-4-AMINOANTIPYRENE FOR THE MEASUREMENT OF BODY WATER IN LIVING PIGS. Kay, M.; Jones, A. S.; Smart, R. (Rowett Research Inst., Bucksburn, Scotland). Brit. J. Nutr., 20: 439-48(1966).

Previous results have indicated that ^3H_2O gives higher values for body water than chemical methods. Thus a comparison was made of body water content estimated in 16 pigs at each of 3 weights (27, 55, and 90 kg) with tritium, 4-aminoantipyrene (4-AA), and N-acetyl-4-aminoantipyrene (NAAP). The values obtained were compared with chemical analysis of the whole carcass. For each weight of pig the same activity of ^3H_2O was used for measuring the body water, namely 0.65 mC. The precision of the estimates was greatest for the group of smallest weight. Body water estimates from ^3H_2O dilution were found to be too high by 0.75, 10.8, and 8.6% at 27, 55, and 90 kg live weights, respectively. An overestimate in body water was expected because of the exchange that takes place between tritium and labile hydrogen in the body; this overestimate is usually of the order of 0.5 to 2.0%. Antipyrene was eliminated from the pig at a rate of 55%/hr and could not be used for body water estimations. Measurements with NAAP on pigs tended slightly to underestimate total body water content. Estimates with 4-AA showed no association with the value obtained by chemical analysis. (BBB)

14170 ATOMNO-ABSORBTSIONNYI SPEKTRAL'NYI ANALIZ. (Atomic Absorption Spectral Analysis). L'vov, B. V. Moscow, Izdatel'stvo Nauka, 1966. 392p.

The theory of spectral analysis of atomic absorption is reviewed and the devices and techniques used for atomic absorption measurements are described. Spectrophotometers, preparation of absorption layers, flame photometers, graphite vessels, etc., are discussed. Results of gas analysis, isotopic analysis, concentration of neutral atoms in the gaseous phase, and atomic diffusion coefficients are estimated. (315 references). (R.V.J.)

14171 DETERMINATION OF OXYGEN IN BERYLLIUM: COMPARISON OF NEUTRON ACTIVATION AND Br–MeOH METHODS. Andersen, G. H. (General Atomic Div., General Dynamics Corp., San Diego, Calif.); Kempchinsky, P. C.; Laverty, A. 9p. (CONF-660606–57). DTIE. Gmelin, AED-CONF-66-203-128.

From American Nuclear Society Meeting, Denver.

Two methods for the determination of oxygen in beryllium were investigated. The neutron activation method was quicker than the bromine–methanol colorimetric or titration method and comparison of data obtained by the two methods over a period of time indicate that they are comparable in precision. The activation method was capable of determining oxygen at much lower levels than the bromine–methanol method. Fluorine is the only element that may interfere with the determination of oxygen in beryllium by activation analysis. (D.H.M.)

14172 METHODS OF RADIOCHEMICAL ANALYSIS. Geneva, World Health Organization, 1966. 164p. Pound 1 3s. 6d.; $4.75; Sw. fr. 14.- (Clothbound Edition).

Methods for determining radioisotopes are described. Wherever possible, two methods are given for each nuclide: one highly sensitive and another perhaps less sensitive but rapid. Types of radioactive contamination likely to arise from various sources and the problems involved in measurement of environmental and human contamination are considered. The proper choice and collection of samples are described. The various types of errors that may affect assays of radioactivity and the checking procedures that may be adopted to counteract them are assessed. (M.C.G.)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 14240, 14242, 14286, 14805, and 14825.

14173 (AD–639219) TOTAL SOLVATION ATMOSPHERES OF THE ALKALI METAL CATIONS IN AQUEOUS SOLUTION. Horne, R. A.; Birkett, J. D. (Little (Arthur D.) Inc., Cambridge, Mass.). Sept. 30, 1966. Contract Nonr-4424(00). 14p. (TR–24). CFSTI $3.00 cy, $0.65 mn.

Estimates of the total number of water molecules in the hydration atmospheres of the alkali metal cations based on the cationic isotope effect on conductance, the ratio of the limiting conductances, and the H_2O-D_2O isotope effect on conductance give values in agreement with the earlier estimate based on the minimum in the concentration dependence of the Arrhenius activation energy of viscous flow. (auth)

14174 (ANL–7029, pp 15-24) FRAGMENTATION OF HYDROCARBONS. Stanton, H. E.; Wexler, S. (Argonne National Lab., Ill.).

Measurements of the kinetic energy released in the fragmentation of ion-molecule complexes indicate that very little is released in the three reactions examined. (auth)

14175 (BNL–10850) KINETIC ISOTOPE EFFECTS IN THE REACTION OF TRIFLUOROMETHYL RADICALS WITH HYDROGEN. Kibby, Charles L.; Weston, Ralph E. Jr. (Brookhaven National Lab., Upton, N. Y.). [1956]. Contract AT(30-2)-Gen-16. 10p. (CONF-670401–2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 153rd National Meeting, American Chemical Society, Miami Beach, Fla.

The reaction between trifluoromethyl radicals and molecular hydrogen, a simple hydrogen atom transfer, was chosen as being likely to yield precise experimental data with which to test theoretical calculations of kinetic isotope effects. All four abstraction reactions between CF_3 and H_2, HD, and D_2 were studied at 365 to 605°K. The radicals were generated by photolysis of hexafluoroacetone, and abstraction rates measured relative to the CF_3 recombination rate. Arrhenius forms of the data are: $\ln(k_{HD}/k_{DH}) = -0.25 + 860/RT$, $\ln(k_{H_2}/k_{D_2}) = 0.25 + 1065/RT$, $\ln(k_{DH}/k_R^{1/2}) = 12.96 - 11630/RT$, $\ln(k_{D_2}/k_R^{1/2}) = 12.55 - 11570/RT$. The Arrhenius plots showed positive curvature, with rates falling off more slowly at low temperatures than expected. This may be due to tunnelling, although other corrections to the Arrhenius equation also fit the data. (P.C.H.)

14176 (COO–716-026) CERIUM–OXYGEN–NITROGEN SYSTEM. Manske, Kenneth J.; Eick, Harry A. (Michigan State Univ., East Lansing. Dept. of Chemistry). Dec. 15, 1966. Contract AT(11-1)-716. 12p. (CONF-670401–5). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For Presentation at 153rd National Meeting, American Chemical Society, Miami Beach, Fla.

Phase studies on the Ce–O–N system showed that it exhibits fcc symmetry. However, the Ce–O–N phase cannot be regarded as a solid solution of either CeO_2 or Ce_2O_3 in cerium nitride, since CeO_2 has the fluorite type cubic structure and Ce_2O_3 has the trigonal "A" type lanthanon sesquioxide structure. Cerium nitride may be considered an interstitial compound in which the nitrogen atoms are located in holes between the cerium atoms situated on a fcc lattice. The oxygen ion with a radium of 1.40 Å could substitute easily for the nitride ion of radium 1.53 Å. Vaporization data for cerium nitride are tabulated. Methods for preparing the system are discussed in detail. (P.C.H.)

14177 (COO–1140-152) TITANIUM–VANADIUM–OXYGEN SYSTEM. PART I. PHASE STUDY. PART II. STRUCTURE STUDY. PART III. VAPORIZATION STUDY. Lin, Sin-Shong (Kansas Univ., Lawrence. Dept. of Chemistry). Nov. 8, 1966. Contract AT(11-1)-1140. 381p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

The phase behavior, crystal structure, and vaporization behavior of the Ti–V–O system was investigated. The phase behavior of the system was studied by x-ray diffraction techniques. The ternary samples were prepared by arc-melting appropriate mixtures of the binary oxides followed by annealing. More than fifty ternary samples were prepared between the compositions M_2O and MO_2. The samples prepared in the MO region were found to disproportionate into sesquioxides and suboxides. A complete solid solution region from Ti_2O_3 to V_2O_3 and a new phase having the composition Ti_2VO_5 were established. A wide homogeneity range of VO_2 in TiO_2 was found. Some phase relations have been established in this system, and finally, the partial phase diagram was constructed from the available information. The structure study of the system included x-ray single crystal investigation of $Ti_{3-x}V_xO_5$ with x = 0.375, Ti_2VO_5, and $Ti_{0.5}V_{0.5}O_2$. The symmetry of Ti_2VO_5 was found to be orthorhombic and that of $Ti_{0.5}V_{0.5}O_2$ was tetragonal. The exact structure of the latter is not known. The vaporization behavior was studied by means of successive vaporization, Knudsen effusion, and mass spectrometric investigations of the ternary samples. The successive vaporization was carried out on seven samples in open crucibles. The compositions of the residues were found to become closer to Ti_3O_5 after evaporation. Interaction between the crucible and sample was observed. The Knudsen effusion experiment was employed to measure vapor pressures of the Ti_2VO_5 sample, from which the heat of vaporization was obtained by the second law method and incongruent vaporization of this sample was established. The vaporization behaviors of three compositions in the titanium–vanadium–oxygen system, V_2O_3, Ti_2VO_5, and $Ti_{0.5}V_{0.5}O_2$, were investigated. A mass spectrometer was used to analyze the vapors effusing from a tungsten Knudsen crucible heated from 1200 to 1800°C. X-ray diffraction techniques were used to identify phases present in the residues. From temperature coefficient measurements, the heats of vaporization for the different reactions were determined. The identities, relative abundances, temperature coefficients of intensity, and appearance potentials of the ions found are presented and discussed. (P.C.H.)

14178 (EURAEC–1294) STUDY OF A FEW METAL OXIDATION PROBLEMS AND APPLICATION OF IMPEDANCE MEASUREMENT METHODS TO THE STUDY OF CORROSION RESISTANCE IN WATER. Quarterly Report No. 11, Parts 1 and 2, October 1–December 31, 1964. (Brussels Univ. (Belgium)). Contract 012-63-10 TEEB. 20p. (EUR–2811). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

In order to characterize more accurately the various oxidized states of metals, studies were made on the nature of the state commonly called reduced considered as the surface state prevailing in the so-called double layer voltage zone between 0.4 and 0.8 V/hydrogen electrode. Platinum was used as the electrode. A theory providing a satisfactory explanation of the results obtained so far is that the oxide formed at 1.20 V/hydrogen electrode is quickly but partially reduced at reference voltage $\tilde{E}$, with complete reduction occurring very slowly ($\tilde{T} > 2$ hr) at voltage $\tilde{E}$, becoming quicker as the voltage becomes less negative. This may show differential reducibility of the oxide as a function of its covering. The preparation of Al and Ni samples for oxidation studies is described. (P.C.H.)

14179 (MLM–1361) DETERMINATION OF THE SHRINKAGE OF ADHESIVES DURING CURE. Fischbein, R. A.; Dichiaro, J. V. (Mound Lab., Miamisburg, Ohio). Jan. 20, 1967. Contract AT(33-1)-Gen-53. 11p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The shrinkage of several adhesive formulations was determined by monitoring the change in the buoyancy of the adhesive in water. Shrinkages ranged from 2% to more than 6% for all formulations tested, with the exception of two methyl cyanoacrylate adhesives,

which had much higher shrinkages. The determination of the total shrinkage of Eastman 910 adhesive under a variety of curing conditions is also described. (auth)

14180 (N-66-37207) CHEMICAL REACTIVITY OF HYDROGEN, NITROGEN, AND OXYGEN ATOMS AT TEMPERATURES BELOW 100 DEG K. Final Technical Report, December 1, 1962–December 31, 1965. McGee, Henry A. Jr. (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). July 1966. 106p. (NASA-CR-78022). CFSTI $3.00 cy, $0.65 mn.

Studies were made on the chemistry at cryogenic temperatures of systems that appear to be of significance in cometary phenomenon and in the atmospheric and surface chemistry of the Jovian planets. Several experimental arrangements for analyzing reactive gases and cryogenically stable liquids and gases are discussed. They include a cryogenic inlet system for a time-of-flight (TOF) mass spectrometer, an alternative experimental assembly using a small inexpensive magnetic mass spectrometer, fast inlet systems for use with several high energy dissociative processes, and two modifications for increased sensitivity of the TOF spectrometer. Several chemical reaction systems were investigated using these apparatus. These studies were sometimes exercises in chemical synthesis and sometimes from an interest in conducting reactions between the atoms and several simple molecules of carbon, hydrogen, oxygen, and nitrogen to relate the chemical behavior at cryogenic temperatures to that at more ordinary temperatures. Data on reactions of atomic hydrogen with ethane, ethylene, acetylene, nitric oxide, and liquid ozone; of atomic oxygen with ammonia; and of diazomethane with liquid ketene are presented. (STAR)

14181 (N-67-10882) STUDY OF THE STRUCTURE OF THE TRANSITION METAL HYDRYLS. Final Report. Magee, Charles B.; Schmidt-Collerus, Josef J. (Denver Univ., Colo.). Oct. 1966. 15p. (NASA-CR-79747; DRI-2357). CFSTI $3.00 cy, $0.65 mn.

Studies were made on the crystal and molecular structures of the transition metal hydryls, principally the rhodium hydryls of formulas: $(LiH)_4$ RH and $(LiH)_4$ RhH. Many attempts were made to observe the infrared absorption spectra of these and other hydryl compounds using the mull technique. An evaporation technique was developed for obtaining thin films of materials on KBr plates for infrared analysis. This technique proved to be very successful for LiH and LiD, but, when applied to the hydryls, decomposition took place during evaporation and the films were not representative of the original compounds. Single-crystal x-ray diffraction analysis resulted in the unambiguous determination of the unit cell type and size of $(LiH)_4$ Rh. The cell is body centered tetragonal with $a_0 = b_0 = 6.36A°$ and $C_0 = 4.09A°$. The volume of this cell is 1.65×10^{-22}cc, and the theoretical density, based on two $(LiH)_4$ Rh molecules per cell, is 2.71 g per cc. (auth)

14182 (ORNL-4068) X-RAY DIFFRACTION DATA ON LIQUID CARBON TETRACHLORIDE AT 25°C. Danford, M. D.; Narten, A. H.; Levy, H. A. (Oak Ridge National Lab., Tenn.). Feb. 1967. Contract W-7405-eng-26. 25p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The scattering of x rays from the free surface of liquid carbon tetrachloride at 25°C was measured and analyzed. The diffractometer used was specially designed for the study of liquid samples. Both the raw data and the intensity and radial distribution functions derived from them are presented in tabulated form. The experimental radial distribution function is in essential agreement with previously published work on carbon tetrachloride, showing, however, much higher resolution. Intramolecular distances derived from the diffraction data are in excellent agreement with those obtained from gas scattering experiments. (auth)

14183 (ORO-2858-18) STABLE ISOTOPE TRACER STUDIES. Progress Report, June 1, 1966–May 31, 1967. Gordon, Gilbert (Maryland Univ., College Park. Dept. of Chemistry). Contract AT(40-1)-2858. 11p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Results are reported for studies on: kinetics of reaction between chlorine dioxide and potassium iodide in aqueous solution; and data handling in ^{18}O tracer studies. Developments are also reported for studies on: reactions between (1,10-phenanthroline) iron(II) sulfate and aqueous solutions of $NaClO_2$ and ClO_2; uranium(IV) and (V) reactions with dissolved chlorine and aqueous HOCl; and diffusion of ^{18}O in single crystals of metal oxides. (P.C.H.)

14184 (ORO-3234-4) TRACER AND ISOTOPE EFFECT STUDIES IN ORGANIC CHEMISTRY. Annual Progress Report. Fry, Arthur (Arkansas Univ., Fayetteville. Dept. of Chemistry). Jan. 15, 1967. Contract AT(40-1)-3234. 71p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments are reported for studies on: rearrangement of aliphatic ketones on solid supported phosphoric acid catalyst; disproportionation in acid-catalyzed rearrangements of aliphatic ketones; reactions of aromatic-aliphatic ketones on solid supported phosphoric acid catalyst; rearrangements of carbon-14 carbonyl and phenyl-labeled phenyl benzhydryl ketone and phenyl benzyl ketone; rearrangement of pivalophenone and related compounds in perchloric acid using ^{14}C tracer; chlorine isotope effects in solvolysis of substituted benzoyl chlorides; ^{14}C isotope effects on nucleophilic displacement reactions of substituted benzyl chlorides and on timing of bonding changes in the reactions of electron deficient species; ^{18}O exchange on substituted nitrobenzenes and between p-substituted benzophenones and water at low acid and base concentrations; ^{15}N exchange between substituted benzamides and ammonia; and stereochemistry of carbene and carbenoid insertion reactions. (P.C.H.)

14185 (SC-R-65-930(Vol.2)) PHYSICAL PROPERTIES OF FUSED SALT MIXTURES: EUTECTIC COMPOSITIONS AND MELTING POINTS. Data from Open Literature, 1963–June 30, 1965. Clark, Paul V. (Sandia Corp., Albuquerque, N. Mex.). Nov. 15, 1966. Contract AT(29-1)-789. 236p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Data on eutectic compositions and melting points of fused salt mixtures are tabulated in two complementary tables arranged according to fused salt systems and melting points. Approximately 2700 references are given to literature data for the period 1907 through June 30, 1965. A cumulative coordinated index for vols. I and II is included. (P.C.H.)

14186 (UCRL-17161) THE CONFIGURATION AND ENERGY OF DEFECTS ON THE (100) SURFACE OF A MOLECULAR CRYSTAL. Burton, J. J.; Jura, George (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1966. Contract W-7405-eng-48. 25p. (CONF-661209-3). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Symposium on Fundamentals of Gas-Surface Interactions, San Diego, Calif.

Using a Lennard-Jones 6-12 potential function to represent the interactions of the atoms, the binding energies of neon, argon, and krypton atoms in and above the (100) surface of argon were computed. Relaxations of the defects were considered and found to be small; however relaxation appreciably affected the energies of the defects. The binding energies of neon, argon, and krypton atoms above the (100) argon surface were 687, 1367, and 1682 cal, respectively. The binding energies of neon, argon, and krypton atoms in the (100) argon surface were 1290, 2603, and 3160 cal, respectively. Relaxation appreciably affected the binding energies. The free energy of formation of a mole of vacancies on the (100) surface of argon was found to be $\Delta F = 1236 - 3.58\ T$ cal. This implies that at the melting point of argon there is one vacancy per three hundred (100) surface sites on 2×10^{12} per cm^2 of surface. (auth)

14187 HYDROCARBONS FROM THE LOW-TEMPERATURE HEATING OF KEROGEN. Hoering, T. C.; Abelson, P. H. (Carnegie Institution, Washington, D. C.). Carnegie Inst. Wash., Pap. Geophys. Lab., No. 1440, 256-8 (Dec. 1964).

Evidence is presented for the exchange of deuterium of D_2O with the labile organic hydrogen in kerogen. One g of a kerogen concentrate from the Green River shale was digested with 10 g of D_2O at 100°C for 7 days. The gases were then collected and fractionated. The fraction not condensed by liquid N_2 consisted mainly of methane. The methane was analyzed in the mass spectrometer and found to contain 9.4% monodeuterated methane, CH_3D. In the ethane plus propane fraction, purified and analyzed by the mass spectrometer and by gas-liquid chromatography, the ir spectrum showed the presence of deuterated hydrocarbons as indicated by the adsorption at 4.60 μ. The fraction containing hydrocarbons from butane to heptane also showed such adsorption at 4.60 μ. This indicates that hydrocarbons are produced by a chemical reaction of components of the kerogen. Pure hydrocarbons do not exchange their hydrogens with deuterated water under the experimental conditions employed. Several possible mechanisms are offered for the production of deuterated hydrocarbons. (BBB)

14188 STRUCTURE OF SOME HYDROXO NITRATES OF THORIUM. Johansson, Georg (Royal Inst. of Tech., Stockholm). Svensk Kem. Tidskr., 78: 486-9 (1966).

Crystallographic data from x-ray diffraction studies are given for the 2 basic Th nitrates, $Th_2(OH_2(NO_3)_6(H_2O)_3$ and $Th(OH)_2(NO_3)_2(H_2O)_x$. The first is formed from discrete dinuclear complexes $Th_2(OH)_2(NO_3)_6(H_2O)_6$ in which the Th atoms are joined by a double hydroxo bridge. The second contains infinite $[Th(OH)_2^{2+}]_n$ chains. X-ray scattering from hydrolyzed Th nitrate solutions indicated that the dinuclear-hydroxo complexes formed at low OH : Th ratios have a structure very similar to that of the dinuclear complexes found in the crystals. The dinuclear complexes are neutral and are joined to other groups by H bonds and van der Waals contacts. The coordination number of each Th atom is 11; however, if each nitrate group is counted as only 1 ligand the coordination number is 8 as usually found for Th compounds. The coordination polyhedron is a distorted dodecahedron. (BBB)

14189 REINVESTIGATION OF THE OXYGEN-EXCHANGE BETWEEN WATER AND PHOSPHATE DURING THE HYDROLYSIS OF UREA BY UREASE. Kull, Frederick J.; Jones, Mary Ellen (Brandeis Univ., Waltham, Mass.). Biochem. Biophys. Res. Commun., 22: 303-7(Feb. 3, 1966).

The ^{18}O exchange between $H_2{}^{18}O$ and orthophosphate catalyzed by urease was studied. The hydrolysis of urea in $H_2{}^{18}O$ and phosphate buffer was done at pH 6.0 and 6.8. At pH 6 only part of the urea was hydrolyzed after 1 hr at 30°C, while at pH 6.8 hydrolysis was complete. In all situations the ^{18}O content of the orthophosphate, expressed as at. %, was only the natural abundance, while if one atom of ^{18}O was incorporated into each molecule of orthophosphate, the ^{18}O content observed would have been 0.375 at. %, or 0.171 at. % excess. The incorporation of one atom of ^{18}O into 50 μmoles of phosphate could be detected by this method, but incorporation of one atom of ^{18}O into 10 μmoles of orthophosphate is difficult to detect. It was concluded that under the conditions used there is no incorporation of ^{18}O from water into orthophosphate buffer during the hydrolysis of urea by urease. (BBB)

14190 SOME BROMO-COMPLEXES OF QUINQUEVALENT PROTACTINIUM, NIOBIUM, AND TANTALUM. Brown, D.; Jones, P. J. (Atomic Energy Research Establishment, Harwell, Eng.). J. Chem. Soc. (A), 247-51(1967).

Hexabromo-protactinates(V), -niobates(V), and -tantalates(V), RM^VBr_6 (R = NMe_4, NEt_4, and Ph_3BuP; M^V = Pa, Nb, and Ta), were prepared from methyl cyanide solutions of the appropriate pentabromide. Niobium(V) and tantalum(V), but not protactinium(V), formed complexes of the type $NMe_4M^VBr_6$, CCl_4 (M^V = Nb and Ta) on the addition of excess of carbon tetrachloride to the tetramethylammonium hexabromo-complex dissolved in methyl cyanide. Some chemical properties, infrared spectra, and x ray powder diffraction patterns are reported for these complexes and for the methyl cyanide complexes $PaBr_5$, $3CH_3CN$ and M^VBr_5, CH_3CN (M^V = Nb and Ta). (auth)

14191 SOME ANHYDROUS HEXAHALOGENO-COMPLEXES OF QUADRIVALENT PROTACTINIUM. Brown, D.; Jones, P. J. (Atomic Energy Research Establishment, Harwell, Eng.). J. Chem. Soc. (A), 243-7(1967).

Hexachloroprotactinates(IV), R_2PaCl_6 (R = Cs, NMe_4, and NEt_4), were prepared by reaction of the tetrachloride with the appropriate cation chloride in concentrated hydrochloric acid (R = Cs) or methyl cyanide (R = NMe_4 and NEt_4). Analogous hexabromoprotactinates(IV), R_2PaBr_6 (R = NMe_4 and NEt_4), and the hexaiodocomplex $(Ph_3MeAs)_2PaI_6$ were prepared from the component halides in anhydrous methyl cyanide. Some chemical properties, infrared spectra, and x-ray powder diffraction results are reported for these compounds and compared with data for some analogous quadrivalent actinide complexes. (auth)

14192 PRECISE REPRESENTATION OF VOLUME PROPERTIES OF WATER AT ONE ATMOSPHERE. Kell, G. S. (National Research Council, Ottawa). J. Chem. Eng. Data, 12: 66-9(Jan. 1967).

The density of ordinary water from 0 to 150°C is represented by a rational function with seven parameters. Similar functions, with fewer parameters, are given for D_2O, $H_2{}^{18}O$, $D_2{}^{18}O$, and T_2O. The density, specific volume, thermal expansivity, and compressibility of ordinary water are given at intervals of 2° from −20 to −10°C and at intervals of 1° from −10 to +110°C. The density of D_2O is given at 5° intervals from 0 to 101°C. (auth)

14193 THE $\Delta\nu = 0$ SEQUENCE IN THE $d^1\Sigma^+ - c^1\Pi$ SYSTEM. Whittaker, F. L. (Imperial Coll. of Science and Tech., London). Proc. Phys. Soc. (London), 90: 535-41(Feb. 1967).

A study of high-dispersion emission spectra of NH and ND in the region 2460 to 2560 Å yielded the following rotational constants for the $d^1\Sigma^+ - c^1\Pi$ band system: $B_v' = 14.409$(NH), 7.693(ND), $\alpha_e' = 0.634$(NH), 0.263(ND), $D_0' = 1.666 \times 10^{-3}$(NH), 4.75×10^{-4}(ND), $B_v'' = 14.697$(NH), 7.841(ND), $\alpha_e'' = 1.015$(NH), 0.393(ND), $D_0'' = 2.19 \times 10^{-3}$(NH), 6.18×10^{-4}(ND), all in cm^{-1}. These constants are consistent with the isotope effect. Approximate vibrational constants were calculated. (auth)

14194 EQUILIBRIUM STUDIES OF URANYL COMPLEXES. IV. REACTIONS WITH CARBOXYLIC ACIDS. Rajan, K. S.; Martell, A. E. (Illinois Inst. of Tech., Chicago). J. Inorg. Nucl. Chem., 29: 523-9(Feb. 1967).

Equilibria involved in the interaction of uranyl ion and phthalic, maleic, oxalic, malonic, succinic, and propane-1,2,3-tricarboxylic acids in aqueous solutions were investigated by means of potentiometric measurement of hydrogen ion concentration at 25°C and ionic strength 1.00 (KNO_3). Phthalic and maleic acids form complexes with a 1:1 molar ratio of ligand to metal ion, with $\log K_1$ = 4.38 ± 0.03 and 4.46 ± 0.05, respectively. Malonic acid forms complexes having molar ratios of 1:1 and 1:2, with $\log K_1 = 5.66 \pm 0.02$ and $\log K_2 = 4.00 \pm 0.02$. Oxalic acid interacts strongly with the uranyl ion to form a complex having a 1:2 molar ratio of metal to ligand ($\log \beta_2 = 9.1 \pm 0.2$). The interactions of uranyl ion with succinic and with 1,2,3-propane tricarboxylic (tricarballylic) acid are very weak. Potentiometric measurements carried out over a wide range of concentration indicate that all of these ligands form only mononuclear uranyl chelates in the pH range 2 to 4. (auth)

14195 PREPARATION AND PROPERTIES OF URANIUM METAPHOSPHATE, $U(PO_3)_4$. Baskin, Y. (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem., 29: 383-91(Feb. 1967).

Single crystals of alpha and beta-$U(PO_3)_4$ were prepared by heating U_3O_8 or UO_2 with P_2O_5 in the temperature range from 400 to 1100°C. Reaction of UP, UO_2, or U_3O_8 with concentrated phosphoric acid produced a green liquid, which also yielded $U(PO_3)_4$ on heating at or above 400°C. Crystallographic, powder diffraction, optical and ir absorption data are presented for the two allotropic forms. Phase transformation and thermal decomposition studies were conducted using x-ray diffraction, differential thermal analysis, and thermogravimetric analysis. (auth)

14196 ENTHALPIES OF SOLUTION AND FORMATION OF SOME URANIUM OXIDES. Fitzgibbon, George C.; Pavone, D.; Holley, Charles E. Jr. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Eng. Data, 12: 122-5(Jan. 1967). (LA-DC-8016).

The enthalpies of formation of U_4O_9, β-U_3O_7, and γ-UO_3 were determined to be $\Delta H_{f\,298.15°K.}$ = −1078.1 ± 3.6, −818.4 ± 2.8, and −292.3 ± 1.4 kcal per mole, respectively. The method used consisted of combining the known enthalpies of formation of $UO_{2.028}$ and U_3O_8 with data obtained from enthalpy of solution measurements of samples of U_4O_9, U_3O_7, and U_3O_8 and of mixtures of $UO_{2.028}$ and $UO_{2.993}$ of corresponding compositions. An aqueous $0.057\underline{M}$ $Ce(SO_4)_2 - 1.5\underline{M}$ H_2SO_4 solution was used as the solvent. (auth)

14197 IDEAL GAS THERMODYNAMIC FUNCTIONS OF TERBIUM, ERBIUM, THULIUM, AND PLUTONIUM. Feber, Roy C.; Herrick, C. C. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Eng. Data, 12: 85-9(Jan. 1967). (LA-DC-7990).

Improved ideal gas thermodynamic functions are calculated for monatomic terbium, erbium, thulium, and plutonium using recent energy level data. The functions are tabulated from 100 to 6000°K at 100° intervals. (auth)

14198 SIMPLE METHOD FOR ISOTOPIC AND MOLECULAR EXCHANGE INVESTIGATION IN LIQUID–GAS SYSTEM. Dorabialska, A.; Bem, H. (Technical Univ., Lodz, Poland). Rocz. Chem., 40: 1999-2009(1966). (In Polish).

An apparatus for investigations of kinetics and equilibrium of isotopic exchange at the surface in the liquid−gas system was constructed. Investigations concerned the exchange of tritium and deuterium with protium in water. Routine investigations comprised two groups with tritium, and with deuterium. In both cases the concentration of isotope in liquid phase as function of the time of surface exchange, the number of isotopic atoms captured in time unit by the unit of surface, and the activation energy of exchange were determined. In addition, the degree of deuterium exchange as function of the pressure was investigated. (auth)

14199 INFRARED SPECTRA OF URANYL NITRATE IN KETONIC SOLUTIONS. Kedzia, B.; Jezowska-Trzebiatowska, B. (Technical Univ., Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 14: 631-7(1966).

The infrared spectra of uranyl nitrate compounds in acetone, 2-butanone, 3-methyl-2-butanone, 4-methyl-2-pentanone, cyclohexanone, and 2-heptanone were studied. Fundamental frequencies of uranyl and nitrate ions observed in the spectra are tabulated. Results pointed toward a great similarity in the inner coordination spheres of the compounds. (J.G.B.)

14200 KINETICS OF THE REACTION BETWEEN URANIUM OXIDE (U_3O_8) AND IRON(III) IONS IN SULFURIC ACID. Sobkowski, Jerzy; Stuglik, Zofia; Minc, Stefan (Univ. of Warsaw). Nukleonika, 11: 799-806(1966).

The rate of the reaction between uranium oxide (U_3O_8) and Fe(III) ions in sulfuric acid solutions was investigated. It was established that dissolution of 1 mole of U_3O_8 is accompanied by reduction of 2 gram-ions of Fe(III) and the reaction may be represented as $U_3O_8 + 2Fe(III) + 4H^+ \rightarrow 3U(VI) + 2Fe(II) + 2H_2O$ The rate of dissolution of U_3O_8 samples in molar sulfuric acid was investigated at varying initial Fe(III) concentrations and various temperatures. The effects of stirring on the rate of the oxidation of U_3O_8 were studied. Comparisons of the results of the reaction in sulfuric acid and perchloric acid showed that the reaction proceeds in perchloric acid much slower than it does in sulfuric. Rate constants of the reactions in sulfuric acid at various temperatures are given. (D.H.M.)

14201 TRITIUM ISOTOPE EFFECTS IN THE OXIDATION OF HYDROGEN AND METHANE. PART I. TRITIUM ISOTOPE EFFECT IN THE OXIDATION OF SINGLY LABELLED METHANE. Zielinski, Mieczyslaw (Univ. of Warsaw). Nukleonika, 11: 807-9(1966).

The tritium isotope effects during oxidation of a $CH_4 + CH_3T$ mixture with CuO at 700 to 750°C were investigated. Results indicate that the C–H bond rupture is the rate determining step in the process of oxidation of CH_4 with CuO. The partial oxidation reactions of tritiated hydrogen with N_2O were studied at 400 to 600°C. (D.H.M.)

14202 PRECIPITATION AND HYDROLYSIS OF URANIUM(VI) IN AQUEOUS SOLUTIONS. V. THE COMPOSITION OF PRECIPITATES FROM URANYL NITRATE–POTASSIUM HYDROXIDE–K, Ca, Sr, Ba, AND Eu NITRATE SOLUTIONS. Tomazic, B.; Branica, M. (Ruder Boskovic Inst., Zagreb). Croat. Chem. Acta, 38: 249-62(1966).

Studies were carried out to elucidate the role of neutral electrolytes, K, Ca, Sr, Ba, and Eu-nitrates, on the precipitation of U(VI) from the system: 10^{-3} M uranyl nitrate–varying concentration KOH. Precipitation in solutions without the neutral electrolytes present depends on the concentration of the uranyl nitrate. The lower the concentration of uranyl nitrate the higher is the ratio $Z = [KOH]/[UO_2(NO_3)_2](M/M)$ at which precipitation occurs. In a narrow concentration range of KOH, the decrease of precipitation of U is attributed to the formation of negatively charged colloid particles. In the presence of the neutral electrolytes, precipitation begins at a minimum ratio Z = 1.6, and the presence of the electrolyte lowers the colloidal stability of the system. The neutral electrolytes exert the same action as the corresponding hydroxides resulting in the formation of the corresponding uranates. The electrolytes display coagulation and constitution effects. At Z values between 2 and 2.5, heptauranates are formed, and the logarithm of the solubility product for the potassium heptauranate is calculated as -23.5 ± 0.4. With further increase of the Z value, the ratio of metal to U is increased and the final products are probably diuranates. Prolonged contact between the precipitate and the mother liquor causes an increase in precipitation that is accompanied by an increase in the acidity of the mother liquor. The precipitates have a colloidal structure with a microcrystalline structure being observed between $2 < Z < 10$ only. (auth)

14203 PRECIPITATION AND HYDROLYSIS OF METALLIC IONS IN SEA WATER. I. IONIC STATE OF ZIRCONIUM AND THORIUM IN SEA WATER. Bilinski, H.; Branica, M. (Ruder Boskovic Inst., Zagreb). Croat. Chem. Acta, 38: 263-7(1966).

The tyndallometric method is a suitable and promising experimental method for the determination of solubility and precipitation in a broad concentration range. The critical concentrations of the precipitating components and the charge on the ions present in the solution in equilibrium with the solid phase can be determined. The precipitation diagrams of Zr and Th at 50% sea water are shown. The influence of the sea water concentration on the solubility product K_{s4} was investigated for Th. Both elements are, under sea water conditions, probably entirely hydrolyzed without charge. Therefore effective fixation of the studied elements on other solid particles and the surface in sea water is to be expected. (auth)

14204 SIMULTANEOUS VOLTAMMETRIC GENERATION OF U(III) AND SPECTROPHOTOMETRIC OBSERVATION OF THE U(III)–U(IV) SYSTEM IN MOLTEN LITHIUM FLUORIDE–BERYLLIUM FLUORIDE–ZIRCONIUM FLUORIDE. Young, J. P. (Oak Ridge National Lab., Tenn.); Mamantov, Gleb; Whiting, F. L. Contract W-7405-eng-26. J. Phys. Chem., 71: 782-3(Feb. 1967). (ORNL-P-2688).

U(III) and U(IV) were generated in molten $LiF-BeF_2-ZrF_4$ (66:29:5 mole %) containing 2 wt % uranium (as UF_4) by linear-sweep voltammetry at a microelectrode located in the optical path of a spectrophotometer. Absorption spectra of the solution layer immediately surrounding the electrode were obtained a short time after the beginning of electrolysis. The spectra after successive periods of electrolysis are graphed. (J.G.B.)

14205 MECHANISM OF OXYGEN ISOTOPIC EXCHANGE IN MIXTURES OF CARBON MONOXIDE AND OXYGEN IN A QUARTZ VESSEL. Verdurmen, E. A. Th. (Stichting voor Fundamenteel Onderzoek der Materie, Amsterdam). J. Phys. Chem., 71: 678-94(Feb. 1967).

The mechanism of oxygen isotopic exchange processes occurring in a thermally reacting dry mixture of natural CO and O_2, predominantly enriched in the $^{18}O^{18}O$ species, was studied between 500 and 580°C and within the pressure range from 28 to 144 torr, in a quartz reaction vessel. Three independent processes occur: formation of CO_2; oxygen isotopic exchange between CO and O_2; and scrambling of oxygen isotopes in O_2. Scrambling and $CO-O_2$ isotopic exchange are retarded practically equally by the addition of considerable amounts of foreign gases, He, Ar, Xe, N_2, CO_2, and SF_6, whereas the rate of CO_2 formation remains practically constant. Relative efficiencies of various foreign gases for retardation of the exchange processes were obtained. Both scrambling and $CO-O_2$ isotopic exchange were completely inhibited by the addition of small amounts of NO. The processes involved showed similar apparent activation energies between 30 and 35 kcal/mole. The formation of CO_2 was mainly a surface process. Scrambling and $CO-O_2$ isotopic exchange were interpreted in terms of gas-phase chain reactions. The chain carriers are oxygen atoms, originating from a wall reaction between CO and O_2, and excited CO_2 (singlet) molecules formed by radiationless transition from the CO_2 (triplet) association complex of CO and O. Chain termination occurs both by wall recombination of oxygen atoms and by gas-phase third-order reactions. The $CO-O_2$ isotopic exchange is determined by the reactions $O + CO \rightarrow CO_2^*$ (triplet) $\rightarrow CO + O$, and scrambling is ascribed to $O + O_2 \rightarrow O_2^* \rightarrow O_2 + O$ and CO_2^{**} (singlet) + $O_2 \rightarrow CO_2^*$ (triplet) + O_2. No marked deactivation of excited CO_2 was observed. Addition of foreign gases favored third-order gas-phase termination and consequently reduced the O atom to partial pressure. The inhibitory effect of NO is ascribed to very small amounts of NO_2, formed by slow reaction of NO with the O_2 reactant, and acting as an O atom scavenger. The ratio of the rate constant k_{25} of $O + O_2 \rightarrow O_2^*$ and the rate constant k_{28} of $O + CO \rightarrow CO_2^*$ (triplet) was obtained at 500°C, $k_{25}/k_{28} = 7.1 \pm 0.2$. (auth)

14206 THE DIELECTRIC CONSTANT OF WATER AND HEAVY WATER BETWEEN 0 AND 40°. Vidulich, G. A.; Evans, D. F.; Kay, R. L. (Mellon Inst., Pittsburgh). J. Phys. Chem., 71: 656-62(Feb. 1967).

The dielectric constant of H_2O and D_2O was determined at several temperatures between 0 and 40°C using a new design of capacitance cell and a transformer ratio arm bridge in the frequency range from 0.5 to 100 kHz. The electrodes of the cell were completely guarded and shielded and consisted of Pt films fused onto the surfaces of two concentric Pyrex cylinders. Water of extremely low conductance ($0.6 \times 0.8 \times 10^{-7}$ ohm^{-1} cm^{-1} at 25°C) was used. The values at 25°C for ϵ_{H_2O} and ϵ_{D_2O} were 78.39 and 78.06, respectively. The equations $\log \epsilon_{H_2O} = 1.94404 - 1.991 \times 10^{-3}t$ and $\log \epsilon_{D_2O} = 1.94275 - 2.013 \times 10^{-3}t$ fitted the data to better than 0.05% for t between 0 and 40°C. A detailed comparison is made with the more recent work reported in the literature. (auth)

14207 NITROGEN ISOTOPE EFFECTS IN NICKEL–AMMONIA COMPLEX AND AMMONIA SYSTEM. Gupta, A. R.; Sarpal, S. K. (Atomic Energy Establishment, Trombay, India). J. Phys. Chem., 71: 500-8(Feb. 1967).

The nitrogen isotope effect in nickel–ammonia complexes/ammonia equilibrium was determined, using an ion-exchange breakthrough operation, as a function of resin crosslinking and ammonia concentration. The experimental (over-all) single-stage factors were calculated from the data using the material balance equation as well as Glueckauf's theory of ion-exchange columns. The good agreement between the calculated and observed breakthrough curves provides an experimental proof of the validity of Glueckauf's theory. The effect of crosslinking on the height equivalent of a theoretical plate and over-all efficiency of the column is discussed in terms of various parameters such as the diffusion coefficients and the effective single-stage factors. The single-stage separation factors for $Ni(NH_3)_4^{2+}$, $Ni(NH_3)_5^{2+}$, and $Ni(NH_3)_6^{2+}$ vs. ammonia equilibria in the aqueous phase were obtained from an analysis of the data, taking into consideration the equilibrium concentrations of various nickel–ammonia complexes at different ammonia concentrations; the values are 1.0062, 1.0079, and 1.010 respectively. The single-stage factor for the hexaammine nickel–ammonia system was calculated from the available vibrational data for this complex. There was good agreement between the calculated and experimentally determined values for the single-stage factor of the $Ni(NH_3)_6^{2+} - NH_3(aq)$ system. (auth)

14208 MECHANISMS OF ELIMINATION REACTIONS. VIII. THE EFFECT OF ADDED DIMETHYL SULFOXIDE ON RATES, ISOTOPE EFFECTS, AND SUBSTITUENT EFFECTS IN THE REACTION OF 2-ARYLETHYL BROMIDES WITH POTASSIUM t-BUTOXIDE IN t-BUTYL ALCOHOL. Cockerill, Anthony F.; Rottschaefer, Susan; Saunders, William H. Jr. (Univ. of Rochester, N. Y.). J. Amer. Chem. Soc., 89: 901-5(Feb. 15, 1967).

Rates of elimination were determined for the reactions of 2-arylethyl bromides with potassium t-butoxide in t-butyl alcohol containing varying concentrations of dimethyl sulfoxide. Kinetic deuterium isotope effects were determined using 2-phenylethyl and 2-phenylethyl-2,2-d_2 bromides. Hammett reaction constants

were determined with the para substituents methoxyl, methyl, hydrogen, and bromine. The temperature range was 30 to 50°C, and the dimethyl sulfoxide concentration was varied between 0 and 2.23M; most measurements were made in the 0 to 0.965M region. The rate of reaction increased markedly as dimethyl sulfoxide was added, about 120-fold from 0 to 2.23M. The rate increased much faster than the basicity of the medium as measured by an H-function. In contrast to the effect on rate, neither k_H/k_D nor ρ was changed appreciably by added dimethyl sulfoxide. Possible explanations of these results are discussed. It is suggested that usual definitions of equilibrium or kinetic basicity are not suitable when discussing the effect of "basicity" on transition-state structure in these elimination reactions. (auth)

14209 TRACER STUDIES OF ACID-CATALYZED REACTIONS. VI. DEUTERIUM REDISTRIBUTION AND ISOTOPE EFFECTS IN n-BUTENE ISOMERIZATION OVER ALUMINA AND SILICA–ALUMINA CATALYSTS. Hightower, Joe W.; Hall, W. Keith (Mellon Inst., Pittsburgh). J. Amer. Chem. Soc., 89: 778-87(Feb. 15, 1967).

The mechanism of n-butene isomerization was investigated over alumina and silica–alumina catalysts using deuterium tracers. Microcatalytic experiments showed that only a small fraction of the hydrogen atoms initially present on either catalyst was directly involved in the reaction. Strongly adsorbed residue formed rapidly on silica–alumina, and this underwent considerable hydrogen exchange with subsequent slugs of butene. Intermolecular exchange when d_0-d_8 mixtures were coisomerized in a static reactor showed that one hydrogen atom was transferred between two molecules during both double-bond and cis–trans isomerization, but the relative reactivities of the two species, k_H/k_D, showed no primary isotope effect. These data could be reasonably well explained on the basis of a common sec-butyl carbonium ion intermediate formed on "induced" protonic sites in the residue over silica–alumina. Over alumina, very little residue was formed, and most of that which did form was displaced by subsequent slugs in the microcatalytic experiments. The rate-determining step in both double-bond and cis–trans isomerization involved carbon–hydrogen bond cleavage, as evidenced by large primary isotope effects ($k_H/k_D \sim 4$). Isotopic scrambling occurred when d_0-d_8 mixtures were coisomerized. However, the mixing was almost as extensive in the reactant as in the product, indicating that isotope exchange may have occurred by a process unrelated to isomerization. The data favor the view that cis–trans isomerization occurred by an intramolecular rearrangement, but no decision could be reached concerning double-bond migration. The isomerization reactions over alumina could not be explained on the basis of a single classical concept. (auth)

14210 VIBRONIC SPECTRA OF URANYL CHLORIDE IN SOME ORGANIC SOLVENTS. Kedzia, B.; Jezowska-Trzebiatowska, B. (Technical Univ., Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 14: 645-50(1966).

The spectra of anhydrous and hydrous uranyl chloride in acetone, 2-heptanone, 1,4-dioxane, and TBP were studied. Ten distinct bands were found in the region examined. Frequency differences and force constants are tabulated. The results are very closely related to those of similar studies of uranyl nitrate. (J.G.B.)

14211 UNUSUAL DOUBLET OF URANYL ASYMMETRIC STRETCHING FREQUENCY. Kedzia, B.; Jezowska-Trzebiatowska, B. (Technical Univ., Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 14: 639-43(1966).

In order to investigate more thoroughly a previously reported unusual split band assigned to the uranyl asymmetric stretching frequency, the infrared spectra of uranyl nitrate in acetone were studied. The spectra of anhydrous uranyl nitrate and of all hydrates of uranyl nitrate were found to be identical except for insignificant changes in band intensities. Results indicate that the split is connected with nitrate ion coordination. Four possible structures of the inner coordination sphere of uranyl nitrate dissolved molecules are presented. (J.G.B.)

14212 ACID- AND BASE-CATALYZED HYDROGEN–DEUTERIUM EXCHANGE BETWEEN DEUTERIUM OXIDE AND SIMPLE KETONES. Bothner-By, A. A.; Sun, Colette (Mellon Inst., Pittsburgh). J. Org. Chem., 32: 492-3(Feb. 1967).

Results of measurements using proton NMR on the rate of acid- ($KDSO_4$) and base-catalyzed ($NaOAc$) enolization in D_2O solutions of acetone, methyl ethyl ketone, diethyl ketone, and methoxyacetone are reported. It was found that alkyl or methoxyl substitution affected quite strongly the rate of enolization in both branches of unsymmetrical ketones. The methoxyl substituent accelerated base-catalyzed and retarded acid-catalyzed enolization in both branches. (J.G.B.)

14213 ELECTRON SPIN RESONANCE SPECTRA OF SOME ISOTOPICALLY SUBSTITUTED HYDROCARBON RADICALS. Fessenden, Richard W. (Mellon Inst., Pittsburgh). J. Phys. Chem., 71: 74-83(Jan. 1967). (RRL-2310-175).

Electron spin resonance spectra of the radicals $^{13}CH_3$, $^{13}CD_3$, $^{13}CH_2CH_2$, $CH_2{}^{13}CH_2$, $^{13}CH_2=CH$, and $CH_2=^{13}CH$ were observed in the liquid phase using the technique of in situ electron irradiation of hydrocarbons. The difference in the ^{13}C splittings of CH_3 (38.34 gauss) and CD_3 (35.98 gauss) is interpreted in terms of the amplitude of the out-of-plane vibration. The conclusion drawn is that considerable lack of orbital following occurs. Hyperfine splittings are also reported for the normal and ^{13}C-containing radicals CH_2D and CHD_2 in a krypton matrix and are used to check in more detail the effect of reduced mass upon both proton and ^{13}C splittings. The splitting at the α position in ethyl radical (39.07 gauss) is very similar to that in methyl while the large (107.57 gauss) splitting in vinyl radical reflects the hybrid nature (6.5% s character) of the electron-containing orbital. Splittings at the β positions in both radicals are small: 13.57 gauss for ethyl and 8.55 gauss for vinyl. The result for ethyl radical is in agreement with the simple molecular orbital treatment of the β-carbon splitting. Also reported is the value for a_C at the α position in cyclohexyl radical (41.3 gauss). The results for methyl, ethyl, and cyclohexyl radicals leave little doubt that in each case the three bonds around the radical carbon are coplanar. However, evidence from other work is drawn upon to suggest that perhaps substituted alkyl radicals such as CH_2F, CH_2OH, CH_2CHOH, etc., may have a somewhat nonplanar configuration at the radical carbon. (auth)

14214 SURFACE CONDUCTIVITY AND CONDUCTION MECHANISMS ON ADSORPTION OF VAPORS ON SILICA. Soffer, A.; Folman, M. (Israel Inst. of Tech., Haifa). Trans. Faraday Soc., 62: 3559-69(Dec. 1966).

Surface conductivity of a high surface area porous silica adsorbent was studied upon adsorption of CH_3NO_2, C_6H_6, dioxane, H_2O, and D_2O. For low surface coverages an exponential dependence between conductance and amount of gas adsorbed was found, whereas in the capillary condensation region the exponential dependence changed gradually to a linear one. The temperature dependence of the conductivity, appearance of polarization, and, with D_2O, the detection of electrolytic products proved that the conductivity is of an ionic type. Energies of activation for conduction depended on coverage and decreased with the amount adsorbed. Measurements were performed on surfaces modified by heat treatment, deuteration, and enrichment in Na^+ ions. Possible mechanisms for surface conductivity are suggested. (auth)

14215 OXIDATION OF URANIUM MONONITRIDE AND URANIUM MONOCARBIDE. Dell, R. M.; Wheeler, V. J.; McIver, E. J. (Atomic Energy Research Establishment, Harwell, Eng.). Trans. Faraday Soc., 62: 3591-3606(Dec. 1966).

The oxidation of uranium mononitride UN was investigated and some comparative measurements carried out on uranium monocarbide UC. Powdered UN, of surface area 0.2 to 0.4 m^2/g, oxidized isothermally at a measurable rate in the temperature range 230 to 270°C. The reaction kinetics were independent of oxygen pressure (50 to 760 torr) and the apparent activation energy was 30 to 32 kcal/mole. Complete oxidation led to an amorphous product of composition $UO_3 \cdot N_{0.2-0.4}$ which released nitrogen only with difficulty and recrystallized to αUO_3. The oxidation of UC led finally to UO_3 containing residual CO_2. X-ray studies of both powdered and single crystalline UN revealed that U_2N_3 and UO_2 are formed as intermediate oxidation products. These develop as a layered structure, with the U_2N_3 sandwiched between the underlying UN crystal and an outer layer of UO_2. Both U_2N_3 and UO_2 are epitaxially oriented with respect to the UN, the fc array of uranium atoms being retained. A novel reaction mechanism is proposed to explain these results. This involves lattice diffusion across the product layers with solid/solid reactions taking place at the UO_2/U_2N_3 and U_2N_3/UN interfaces. Experiments with single crystals of UC showed epitaxial orientation of the UO_2 product, but no evidence for higher carbides. (auth)

14216 THE COLLECTION OF URANIUM(VI) ON CELLULOSE PHOSPHATE. Bruce, T.; Ashley, R. W. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Analyst, 92: 137(Feb. 1967).

Cellulose phosphate was employed in the identification of very low concentrations of uranium in pure aqueous solution, in conjunction with x-ray fluorescence measurement. Experimental details are described. Results showed that uranium was collected quantitatively on cellulose phosphate from solutions as dilute as 50 μg per litre. For the x-ray fluorescence measurements excitation at 285 mμ was employed, with fluorescence intensity measured at 495 mμ. The fluorescence intensity was approximately proportional to the amount of uranium on the collecting disc in

the range 1 to 10 μg, but was then unaffected by increasing amounts of uranium. Cellulose phosphate fluoresces under the influence of the exciting light, producing a high blank which makes quantitative measurements impossible. (See also report CRDC-1250). (UK)

14217 VIBRATIONAL RELAXATION OF HYDROGEN CHLORIDE, DEUTERIUM CHLORIDE, AND HYDROGEN BROMIDE AT ROOM TEMPERATURE. Ferguson, Margaret G.; Read, A. W. (Edinburgh Univ.). Trans. Faraday Soc., 63: 61-5(Jan. 1967).

The vibrational relaxation times of HCl, DCl, and HBr were determined by a spectrophone method. Shorter limits to the relaxation times are 1.1×10^{-2}, 1×10^{-2}, and 1.5×10^{-3} sec, respectively. These results agree better with vibration-rotation theory than with vibration-translation theory. The results for HCl are compared with high-temperature shock-tube data. (auth)

14218 THERMODYNAMIC PROPERTIES OF URANIUM COMPOUNDS. PART 3. LOW-TEMPERATURE HEAT CAPACITY AND ENTROPY OF UP AND U_3P_4. Counsell, J. F. (National Physical Lab., Teddington, Eng.); Dell, R. M.; Junkison, A. R.; Martin, J. F. Trans. Faraday Soc., 63: 72-9(Jan. 1967).

Heat capacity measurements were made on UP and $UP_{1.38}$ from 11° to 320°K and values of the standard thermodynamic functions are tabulated. The C_p curve for UP shows a pronounced sharp anomaly at 22.5°K, and also an expected anomaly at 121°K, the latter corresponding to antiferromagnetic ordering of the unpaired electrons at the Néel temperature. The origin of the former anomaly was established, although it may correspond to a transition in the electronic ground state. The entropy increments associated with these anomalies are $S_{22.5^\circ} = 0.45$ cal deg^{-1} mole^{-1} and $S_{121^\circ} = 0.74$ cal deg^{-1} mole^{-1}. U_3P_4 showed a C_p anomaly at 136.5°K for which $S_{136.5^\circ} = 0.51$ cal deg^{-1} mole^{-1}. This effect corresponds to ferromagnetic ordering of the unpaired electrons at the Curie temperature. The relationship between the entropy increments and the ordered magnetic moments is discussed briefly. (auth)

14219 ISOTOPE EFFECTS ON FLAME SPEEDS FOR HYDROGEN AND DEUTERIUM. Gray, P.; Smith, D. B. (Univ. of Leeds, Eng.). Chem. Commun., No. 4, 146-8(Feb. 22, 1967).

Some burning velocity studies in the systems $H_2 + O_2$, $D_2 + O_2$, $H_2 + N_2O$, and $D_2 + N_2O$ are reported. For the oxygen systems the flame speeds differed over the whole composition range studied, always being greater for the hydrogen mixtures, and a similar pattern was observed for the N_2O mixtures. The flammable range is wider for $H_2 + O_2$ systems than for $D_2 + O_2$. Upper explosion limits were also determined for $H_2 + O_2$ and $D_2 + O_2$ systems, the limit being higher for deuterium than for hydrogen. This limit is determined by the efficiencies with which collisions can stabilise the excited species HO_2^* and DO_2^*. Deuterium makes fewer collisions per second and is therefore less successful in stabilizing DO_2^* than hydrogen is in stabilizing HO_2^*. Previous work on these systems is briefly reviewed (also on the $H_2 + Br_2$ and $D_2 + Br_2$ systems). The influence of thermal conductivity is estimated. It was concluded that the possible isotope effect in these flames is about 1.6 for $H_2 + O_2$ and $D_2 + O_2$ and about 1.56 for $H_2 + N_2O$ and $D_2 + N_2O$. The observed isotope effects are 1.4 and 1.3, respectively. Differences between observed and estimated values arise from the contribution of types of elementary reactions such as $H + O_2 \rightarrow OH + O$, and $H + N_2O \rightarrow N_2 + OH$ or $D + N_2O \rightarrow N_2 + OD$, in which no H—H or D—D bond is broken. (UK)

14220 ISOTOPE EFFECTS IN DISSOCIATIVE ATTACHMENT OF ELECTRONS IN METHANE. Sharp, T. E.; Dowell, J. T. (Lockheed Palo Alto Research Lab., Calif.). J. Chem. Phys., 46: 1530-1(Feb. 15, 1967).

Two distinct isotope effects were experimentally observed in negative-ion formation by dissociative attached electrons in deuterium-substituted methanes. In the range from 8 to 13 eV an inverse isotope effect was found in H^- production, $\sigma_H(CH_4) \cong 0.8\sigma_D(CD_4)$. A large direct isotope effect was found in CH_2^- production, $\sigma_{CH_2}(CH_4) > 100\ \sigma_{CD_2}(CD_4)$. The cross section for CH_4 contained two peaks. Mass analysis showed that the lower-energy peak due to H^- overlapped the higher-energy peak due to CH_2^-. The cross section for CD_4 contained only a single peak, due to D^-. (D.H.M.)

14221 THE ABSORPTION SPECTRA OF PROTACTINIUM (IV) AND URANIUM(IV) IN AQUEOUS HYDROCHLORIC ACID. Bagnall, K. W.; Brown, D. (Atomic Energy Research Establishment, Harwell, Eng.). J. Chem. Soc. (A), No. 2, 275-8(1967).

Absorption spectra are reported for protactinium(IV) and uranium(IV) in hydrochloric acid solution (1 to 12M). Spectra of protactinium(IV) in hydrochloric acid solutions containing various amounts of sodium chloride and zinc chloride are discussed in relation to the previously published spectra of solutions prepared by zinc amalgam reduction of protactinium(V). The effect of zinc chloride on the spectra of uranium(IV) solutions is also described. (auth)

14222 ELECTROMIGRATION IN MOLTEN AND SOLID BINARY SULFATE MIXTURES: RELATIVE CATION MOBILITIES AND TRANSPORT NUMBERS. Ljubimov, Vladislav; Lunden, Arnold (Chalmers Univ. of Tech., Gothenburg, Sweden). Z. Naturforsch., 21a: 1592-1600(Oct. 1966).

The electrolytic displacement of two cations relative to each other was studied in solid $(Li,Ag)_2SO_4$ (93 eq. % Li) at 700°C, solid $(Li,K)_2SO_4$ (91% Li) at 575°C and molten $(Li,K)_2SO_4$ (41 to 90% Li). For melts containing more than about 52% Li the Li ions have a higher mobility (at about 740°C) than the K ions, while the latter have the highest mobility in mixtures where K is the more abundant cation. The relative difference ($\Delta b/b$) between the mobilities of the two cations exceeds 15% already at concentrations some 8% off from the equimobility concentration. For the eutectic composition, 80% Li, $\Delta b/b$ was about 60% independent of the temperature (590 to 835°C). For mixtures containing 90% Li it was established that $\Delta b/b$ changes its sign at the melting point. Thus, the mobility of the Li ion was of the order of half the mobility of the other ion in the solid systems, while it was about twice as large in the melt. The cation transport numbers (relative to the anion) were calculated for all experiments, and for the melts also the difference between the cation mobilities. An estimation was made of the obtainable accuracy of electromigration experiments. The experiments with melts were analyzed for isotope effects. The light isotopes were always enriched towards the cathode, independent of whether Li or K had the higher mobility. The magnitude of the isotope effects showed a concentration dependence, i. e., the mass effect (relative difference in mobility divided by relative difference in mass) tended to increase when an ion was dilute, as previously found for other systems. Thus for the melts with 80% Li, the mass effect was higher for K than for Li. (auth)

14223 DIFFUSION OF ^{133}Xe IN UO_2 SINGLE CRYSTALS. Spindler, P.; Lindner, R. (CCR-EURATOM, Ispra, Italy). Z. Naturforsch., 21a: 1723-5(Oct. 1966).

Single crystals of UO_2 were crushed and sieved to a dimension of 30μ. The grains were annealed in purified H_2 for 12 hr at 1000°C and irradiated in the Ispra I reactor in a position corresponding to a flux of 2.2×10^{13} thermal neutrons/cm^2 sec (dose ~10^{18} nvt). The released fission gas was trapped in a cold trap, which was periodically changed and inserted into a well-type scintillation counter for registration of the 81-keV γ line of ^{133}Xe. Characteristic release curves are presented. The total release was of the order of 1%. The change in slope of the curves is explained by trapping phenomena. (M.C.G.)

14224 VAPOR-PRESSURE MEASUREMENTS ON SOLID ZrI_4, HfI_4, AND ThI_4. Gerlach, J.; Krumme, J.-P.; Pawlek, F.; Probst, H. (Technical Univ., Berlin). Z. Phys. Chem., 53: 135-42(1967). (In German).

Vapor-pressure measurements are presented, which were obtained by the method of oscillating quartz fibers on solid ZrI_4, HfI_4, and ThI_4. (tr-auth)

14225 INVESTIGATION OF THE DEUTERIUM EXCHANGE IN SULFUR–ORGANIC COMPOUNDS. Shatenstein, A. I.; Gvozdeva, E. A.; Kamrad, A. G. Isotopenpraxis, 2: 462-6(Dec. 1966). (In Russian).

The reactivity of organic sulfur compounds and the electron effects of sulfur-containing substituents were quantitatively studied by measuring the kinetics of deuterium exchange. The compounds were deuterated specifically. (auth)

14226 OXYGEN EXCHANGE BETWEEN CHROMIUM(VI) OXYANIONS AND WATER. Holyer, R. H.; Baldwin, H. W. (Univ. of Western Ontario, London). Can. J. Chem., 45: 413-19 (Feb. 15, 1967).

The rate of oxygen exchange between ^{18}O-enriched CrO_4^{2-}, $HCrO_4^-$, $Cr_2O_7^{2-}$, and solvent water was measured as a function of pH and total chromium(VI) concentration. The exchange can be explained in terms of the dimerization equilibria $HCrO_4^- + CrO_4^{2-} \rightleftharpoons Cr_2O_7^{2-} + OH^-$ and $2HCrO_4^- \rightleftharpoons Cr_2O_7^{2-} + H_2O$ except at high pH, where slow pH-independent exchange is observed. Rate constants for the reactions of the dimerization equilibria were evaluated from the exchange results, and are in agreement with values obtained by a variety of other methods. (auth)

14227 MODIFICATIONS OF URANYL SULFATE IN RELATION TO THE A AND B SERIES OF BANDS. Pant, D. D.; Pande, D. N. (DSB Government Coll., Naini Tal, India). Indian J. Pure Appl. Phys., 4: 470-8(1966).

The fluorescence and absorption spectra of eight forms of uranyl sulfate, prepared under a variety of conditions of crystallizations and interaction of samples with moisture, was stud-

ied with a view to clarifying the conflicting observations of earlier workers. In general two series of bands designated as A and B were observed with a frequency interval of 242 cm^{-1}, which is close to the frequency of bending vibration of the UO_2 group in the excited state. The occurrence of ν_3 frequency in more than one quantum was observed in one of the forms (dehydrated forms of uranyl sulfate prepared by heating $UO_2SO_4 \cdot 3H_2O$ with concentrated H_2SO_4 at 250°C till the acid was expelled) studied. A thorough investigation of the occurrence, position, and intensity variation with temperature, of the A and B series of bands of the different forms of the uranyl sulfate both in the pure state and in mixtures leads to the conclusion that the levels giving rise to the A and B series of bands belong to the same emitter in the excited state thus disproving the interpretation of E. Rabinowitch and R. L. Belford [Spectroscopy and photochemistry of uranyl compounds (Pergamon Press Ltd, Oxford), 1964], viz. that the two series of bands originate from a mixture of two modifications of uranyl sulfate trihydrate. (auth)

14228 REACTION OF PHOSPHORUS VAPOR WITH COMMERCIAL NICKEL AND TUNGSTEN. Booss, H. J. Metall, 21: 28-30(Jan. 1967). (In German).

The reaction of phosphorus vapor with nickel and tungsten wires was studied at 400 to 700°C and in phosphorus atmospheres of 0.05 to 1 atm. (M.C.G.)

14229 HEXAGONAL URANIUM NITRIDE. Stoecker, H. J.; Naoumidis, A. (Kernforschungsanlage, Juelich, Ger.). Ber. Deut. Keram. Ges., 43: 724-8(Dec. 1966). (In German).

Conditions for producing hexagonal β-uranium nitride were investigated. The latter can be produced in its pure form by heating UN or α-UN_x to 1320 ± 50°C at a N_2 pressure below 1 atm. The homogeneity range of the β-phase extends from about U_3N_4 to U_3N_5 (measured: minimum $UN_{1.34}$, maximum $UN_{1.48}$). α-UN and β-UN are not modifications of the same chemical composition; the $\alpha \rightleftharpoons \beta$ reversals observed by various workers are accompanied by changes in chemical composition. If the nitrogen supply from the gas phase is reduced, then β-UN remains stable even below 900°C. The lattice constants were: $a_0 = 3.698 \pm 0.002$ and $c_0 = 5.839 \pm 0.004$ Å. (auth)

14230 THE I.R. ABSORPTION OF 86 PERCENT ^{18}O–POTASSIUM PERMANGANATE. Pinchas, S.; Samuel, David; Petreanu, E. (Weizmann Inst. of Science, Rehovoth, Israel). J. Inorg. Nucl. Chem., 29: 335-9(Feb. 1967).

The absorption of potassium bromide pellets of normal and labelled potassium permanganate was measured in the 4000 to 220 cm^{-1} region. The assignment of the ν_1, ν_2, ν_3, and ν_4 modes of the permanganate ions to the absorption bands observed at 844, 385, 910, and 407 cm^{-1}, in the case of the normal salt, and at 806, 368, 873, and 386 cm^{-1}, in the case of the labelled salt, was confirmed. The agreement between the observed frequency of the labelled permanganate absorption bands and that calculated theoretically is very good. (auth)

14231 HYDROTHERMAL PRECIPITATION IN SOLUTIONS OF THORIUM NITRATE, FERRIC NITRATE, AND ALUMINIUM NITRATE. Robins, R. G. (Univ. of New South Wales, Kensington). J. Inorg. Nucl. Chem., 29: 431-5(Feb. 1967).

Phase diagrams for the systems $Th^{4+} - ThO_2 - H_2O$, $Fe^{3+} - Fe_2O_3 - H_2O$, and $Al^{3+} - Al_2O_3 - H_2O$ were determined and are presented in the form of temperature–pH plots. The precipitation temperature and the composition of the precipitate formed are shown to be dependent on the pH of the initial nitrate solution. Thermodynamic prediction of phase equilibria in similar systems is outlined. (auth)

14232 SULFUR ISOTOPE EFFECTS IN THE HYDROGEN ION DECOMPOSITION OF POLYTHIONATES. Agarwala, U.; Rees, C. E.; Thode, H. G. (McMaster Univ., Hamilton, Ont.). Can. J. Chem., 45: 181-7(Jan. 15, 1967).

The sulfur isotope effects in the decomposition of tri-, tetra-, and penta-thionate were studied. There are three distinct intermolecular and three distinct intramolecular isotope effects. The experimental results show that the decomposition of these polythionates may be described in terms of a model where the rate-controlling step is the cleavage of a sulfur–sulfur bond, and that the appropriate cleavage forms are $(S_2O_3^-)(SO_3)$, $(S_3O_3)(SO_3^{2-})$, and $(S_4O_3)(SO_3^{2-})$ for tri-, tetra-, and penta-thionate, respectively. (auth)

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Refer also to abstracts 14149 and 14930.

14233 (AD–639389) A STUDY OF ENERGY TRANSFER PROCESSES IN RADIATION CHEMISTRY: TRIPLET–TRIPLET TRANSFER IN POLYBUTADIENE. Technical Report, March 1965–June 30, 1966. Golub, Morton A. (Stanford Research Inst., Menlo Park, Calif.). July 1966. Contract AF 33(615)-2354. 33p. (AFML-TR-66-2921). CFSTI $3.00 cy, $0.65 mn.

Benzene photo- and radiation sensitized cis-trans isomerization of 2-pentene, 2-hexene, 2-heptene, and 2-octene all yield the same photo- and radio-stationary cis/trans ratio, viz., 1.0. Yields of benzene triplet formation and radioinduced unsensitized isomerization of the above olefines are reported. Thin films of polybutadiene containing small amounts of certain triplet-forming organic compounds were isomerized on exposure to ultraviolet light. This demonstrates that triplet-triplet transfer from sensitizer to polymer double bonds is quite efficient in the solid state. (auth)

14234 (AGN–8183) FISSIOCHEMICAL DEVELOPMENT PROGRAM. Monthly Progress Report for the Period February 1966. (Aerojet-General Nucleonics, San Ramon, Calif.). Mar. 1966. Contract AT(04-3)-596. 24p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments are reported for studies on: fission fragment–fuel interaction; operation and nitrogen chemistry in fissiochemical loop; reaction mechanisms for neopentane radiolysis and fission fragment radiolysis of $N_2 - CH_4$; gamma and fission fragment irradiations and analysis of Linac polymer in fissiochemical synthesis; and fissiochemical fuel development. (P.C.H.)

14235 (COO–1088-25) COMPUTER SOLUTION OF GEL-CROSSLINK RELATIONS. Kang, H. Y.; Saito, O.; Dole, M. (Northwestern Univ., Evanston, Ill.). Dec. 20, 1966. Contract AT(11-1)-1088. 8p. (CONF-670401-4). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 153rd National Meeting, American Chemical Society, Miami Beach, Fla.

When a polymer such as polyethylene is subjected to ionizing radiations, covalent bond crosslinks are formed in the solid at room temperature and chain degradation may also occur. However, all mathematical relations deduced to date have failed to be quantitatively applicable, chiefly because they have not been derived for the type of molecular weight distribution that exists in linear polyethylene. A theoretical treatment similar to that of Inokuti, but one based on the Wesslau molecular weight distribution, was carried out. The resulting very complicated equations were solved with considerable success using a CDC-3400 computer, and give the general shape of the dose–gel curve. The initial slope of the dose–gel curve was a sensitive function of the type of molecular weight distribution and the G-value for crosslinking increased with dose. (auth)

14236 (COO–1088-26) TEMPERATURE COEFFICIENT OF CROSSLINKING AND OTHER EFFECTS IN THE IRRADIATION OF POLYETHYLENE. Kang, H. Y.; Saito, O.; Dole, M. (Northwestern Univ., Evanston, Ill.). Jan. 1, 1967. Contract AT(11-1)-1088. 8p. (CONF-670401-3). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 153rd National Meeting, American Chemical Society, Miami Beach, Fla.

A study was made of the temperature coefficient over the range from 35 to 120°C of the radiological processes that occur during the gamma irradiation of polyethylene. To calculate crosslinks from gel–dose data use was made of the Charlesby–Pinner function as modified for a Wesslau molecular weight distribution. Good agreement of the data with the resulting equations was obtained in the case of the initial slope and general shape of the $s + s^{1/2}$ versus dose curve. Deviations at high doses were shown quantitatively to be related to vinylene decay; definite evidence of change of G(X) with dose was obtained. G(X) at zero dose was almost independent of temperature, but at the highest dose studied, 27 MRAD, G(X) increased significantly with temperature. Hydrogen yields increased slightly with temperature, but at the highest temperature, 120°C $G(H_2)$ was practically independent of dose. Material balance was realized to ±0.2 G-units at 35°C and to ±0.1 at 120°C both at zero and 27 MRAD dose. (auth)

14237 (JLI–2901-75) BASIC STUDIES IN RADIATION TECHNOLOGY. Final Report, November 1, 1961–April 30, 1966. (Johnston (William H.) Labs., Inc., Baltimore, Md.). Contract AT(30-1)-2901. 257p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments are reported for studies on: working theory for seeking ionic chain reactions; hydrazine formation in radiolysis of ammonia; ozone formation in radiolysis of oxygen; nitrous oxide dosimeter; ionic chain reactions in radiolysis of alcohol–olefin, amine–olefin, isobutylene–water, thiol–olefin, and silane-olefin systems. Vacuum gas handling systems, high pressure facility, radiation facilities, analytical instrumentation, and a coincidence mass spectrometer are discussed. The present status of radiation chemistry is outlined. (P.C.H.)

14238 (NYO–3682-2) THEORETICAL INVESTIGATIONS OF RADIATION EFFECTS IN IONIC CRYSTALS. Progress Re-

port, February 1, 1966–January 31, 1967. Bartram, Ralph H. (Connecticut Univ., Storrs. Dept. of Physics). Feb. 2, 1967. Contract AT(30-1)-3682. 23p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Theoretical investigations of radiation effects in ionic crystals were conducted to account quantitatively for the optical and ESR absorption spectra of radioinduced defects, and to understand other effects of radiation. The theory of positive g-shifts for F-centers in divalent compounds was developed further and a manuscript prepared for publication. A molecular-orbital calculation of a radioinduced molecule ion, $(AlO)^{3-}$ in Al_2O_3, verified the triplet ground state and yielded a reasonable optical absorption. A Heitler-London calculation was required to obtain the observed zero-field splitting. Further progress was made in calculating the band structure of Al_2O_3. Symmetry-adapted Bloch functions and an analytic potential were constructed, and computer programs written for evaluation of matrix elements. An investigation of the anisotropic luminescence of scintillation counters was initiated. The effect is explained in terms of saturation of luminous efficiency and channeling. A preliminary calculation was based on the equipartition theorem, and a more refined stopping-power formula for channeled particles was obtained. A crystal-field calculation for trapped nitrogen atoms in KN_3 was initiated in an effort to determine the correct defect site. A crystal potential calculation was completed, and matrix elements of Russell–Saunders, crystal potential, spin-orbit and spin-spin interactions were obtained within the ground configuration. (auth)

14239 (ORO-3106-17) DETERMINATION OF MINOR RADIOLYSIS PRODUCTS IN LIQUID CYCLOPENTANE. Hughes, B. Mason; Hanrahan, Robert J. (Florida Univ., Gainesville. Dept. of Chemistry). Sept. 1966. Contract AT(40-1)-3106. 26p. (CONF-660907-8). DTIE.

From American Chemical Society Meeting, New York.

The following substances have been identified as minor products in the gamma radiolysis of cyclopentane at 3×10^{22} eV total dose; 1,4-pentadiene; 2-pentene; cyclopentadiene; 1,3-pentadiene; ethylcyclopentane; vinylcyclopentane; n-heptane; n-octane; propylcyclopentane; propenylcyclopentane or propylcyclopentene; n-decane; pentenylcyclopentane or n-pentylcyclopentene; n-pentylcyclopentane; and cyclopentylcyclopentene. The determination of these products was by parent mass number, gas chromatographic retention times, and/or boiling points of the compounds. Spectroscopic studies of the radiolysis of solutions of cyclopentadiene in cyclopentane are also described. (auth)

14240 (RRL-2310-194) QUARTERLY REPORT [ON RADIATION RESEARCH], OCTOBER 1, 1966–DECEMBER 31, 1966. Fundamental Research No. 6041. (Mellon Inst., Pittsburgh, Pa. Radiation Research Labs.). Jan. 16, 1967. Contract AT(30-1)-2310. 10p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments are reported for studies on: role of O^- in gas phase radiolysis of alkane–nitrous oxide mixtures; radioinduced hydroxylation of nitrobenzene in dilute aqueous solution; yield of thermal ethyl radicals from radiolysis of ethylene–cyclohexane solutions; Meisenheimer complexes of dinitro substituted aromatic ethers; ESR spectra of irradiated plastic crystals; spin relaxation in radioinduced radicals; theory of structure of PF_4 radical; electronic structures of NCN and CNC; reaction of O^- with alcohols in gas phase; EPR spectra of irradiated aqueous solutions; pulse radiolysis of solvated electron; pulse radiolysis of ions in organic media; and the reaction of O^- with N_2O and CO_2 in liquid cyclohexane. (P.C.H.)

14241 (KFK-tr-208) DER SZILARD-CHALMERS-EFFEKT UND SEINE ANWENDUNG. (The Szilard-Chalmers Effect and Its Application). Wang, Lien-Sheng. Translated into German by Peter Buriks (Kernforschungszentrum, Karlsruhe, West Ger.), from Hua Hsueh Tung Pao, No. 9, 264-9(1964). 18p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80 mf.

A bibliographic review is given on the Szilard–Chalmers effect and its uses. The bases of this effect are described and some fundamental questions in the utilization of the Szilard–Chalmers effect for the enrichment of carrier-free radioisotopes are considered. Some examples of Szilard–Chalmers reactions are given. This reaction in strong radiation fields is described. The use of the Szilard–Chalmers effect in the preparation of labeled compounds and experimental techniques is briefly considered. (J.S.R.)

14242 E.S.R. STUDY OF GAMMA IRRADIATED BINARY MIXTURES OF PYRIDINE AND METHANOL. David, C. (Univ. Libre, Brussels); Geuskens, G.; Verhasselt, A.; Jung, P.; Oth, J. F. M. Mol. Phys., 11: 599-600(1966).

The ESR spectra of γ-irradiated mixtures of pyridine in methanol were recorded at various temperatures using clear glassy spheres containing the binary mixture. At 130°K, the observed ESR spectra are independent of the nature of the solvent (deuterated or not); however, the different spectra recorded for pyridine and pyridine-d_5, cannot be attributed to a radical formed by the addition of a hydrogen (or deuterium) from the solvent to the ring. The observed spectra are probably attributable to the α-pyridyl radical. (B.L.M.)

14243 ENDOR MEASUREMENTS IN X-IRRADIATED SODIUM FORMATE. Cook, R. J.; Whiffen, D. H. (National Physical Lab., Teddington, Eng.). J. Phys. Chem., 71: 93-7(Jan. 1967).

ENDOR measurements of the sodium hyperfine coupling to the unpaired electron of the CO_2^- radical anion trapped in irradiated sodium formate were made at 35,000 Mcps and 77°K. The values of the hyperfine and quadrupole coupling constants used to calculate the observed ENDOR transitions are given. Transitions from other sodium and hydrogen nuclei were observed. (auth)

14244 TRAPPED RADICALS. Symons, M. C. R. (Univ. of Leicester, Eng.). Advance. Sci., 23: 163-70(July 1966).

Trapped radicals are discussed in terms of 3 aspects: radicals formed from ionizing irradiation of solids, detection methods, and matrix isolation methods. The primary process when a γ ray interacts with a molecule is discussed. Methods of electron trapping are also considered. The 2 methods used most extensively for studying trapped radicals, uv and ESR spectroscopy, are reviewed. Some examples of experimental spectra are given, including one of trapped hydrogen atoms, as shown by the ESR spectrum of γ-irradiated calcium phosphate. A list of typical radicals is given. (TSS)

14245 RADIATION-INDUCED OXIDATION OF SOME ORGANIC SUBSTANCES WITH MOLECULAR OXYGEN. Saraeva, V. V. (Lomonosov State Univ., Moscow). Petrol. Chem. (USSR) (Engl. Transl.), 5: No. 4, 257-67(1966).

The characteristic features of radioinduced oxidation of various organic compounds with molecular oxygen were considered. Radiation, radiation-thermal, and thermal-radiation type reactions were examined. The conditions in changing from one process to another were established. The effect of dose rate in going from a radiation to a radiation-thermal process was considered. Using the limited data available in the various ranges of temperatures, a curve was plotted by the proposed methods to show the dependence of yields on temperature for various dose rates. The radioinduced oxidation reactions studied concerned the oxidation of isooctane, heptane, isopropyl ether, and isopropyl alcohol. In the low-temperature region the yield of oxidation products depended very little on temperature and was practically independent of dose rate. In view of the fact that the mechanisms of formation of oxidation products were not established with sufficient reliability, the discussion is based entirely on hydrogen peroxide formation. As to the transition from the radiation range to the radiation-thermal range it was pointed out that the temperature at which chain processes take place decreases as the dose rate is decreased. (BBB)

14246 ELECTRON SPIN RESONANCE AND TORSIONAL MOTION OF THE β PROTONS OF THE $HOOC-CH_2-C(OH)-COOH$ RADICAL. Corvaja, Carlo (Univ. of Padua). Trans. Faraday Soc., 63: 26-31(Jan. 1967).

The ESR spectrum of the free radical $HOOC-CH_2-C(OH)COOH$ formed by γ irradiation of single crystals of ammonium malate monohydrate was recorded at different temperatures. The change in the β proton coupling constants with temperature is discussed in terms of a torsional motion about the $C^\alpha-C^\beta$ single bond. The ^{13}C splitting and the hydroxyl proton splitting are correlated to the conformation of the hydroxylic group, which is about 20° out of the radical plane. The temperature dependence of the coupling constant is consistent with the presence of strong intermolecular forces which hinder the motion. They probably arise from hydrogen bonds in the solid state. (auth)

14247 RADIATION-INDUCED ISOMERIZATION OF HEXAFLUOROBENZENE. Fajer, J.; MacKenzie, D. R. (Brookhaven National Lab., Upton, N. Y.). J. Phys. Chem., 71: 784-5(Feb. 1967).

The gamma radiolysis of liquid and gaseous hexafluorobenzene (I) yielded several products which were separated by gas chromatography. Liquid-phase irradiation yields included Dewar C_6F_6, hexafluorobicyclo[2.2.0]hexa-2,5-diene (II); gas-phase irradiation yields included C_6F_6, perfluorocyclohexadiene, and (I). Results confirmed that valence isomerization occurs in the radiation chemistry of C_6F_6. (J.G.B.)

14248 THE RADIOLYSIS OF ETHANOL. V. REACTIONS OF THE PRIMARY REDUCING SPECIES IN THE LIQUID PHASE. Russell, J. C.; Freeman, G. R. (Univ. of Alberta, Edmonton). J. Phys. Chem., 71: 755-62(Feb. 1967).

A study was made of the effects of temperature, acid, and nitrous oxide on the yields of hydrogen precursors in the γ radiolysis of liquid ethanol. The yields of the free-ion solvated

electrons and of those that undergo geminate recombination were calculated and compared to the experimental results. The yields of the various reducing species at 25°C were G(H) = 2.0, $G(e^-_{solv})_{fi}$ = 1.2, G (geminate recombination) = 1.9, G(X) = 0.8, and G(Y) = 1.0. Species X reacts with acid to form hydrogen, but its identity is unknown. Species Y forms hydrogen at high temperatures and it might be an excited molecule. (auth)

14249 RADIATION-INDUCED OXIDATION OF PEPTIDES IN AQUEOUS SOLUTIONS. Atkins, Harriette L.; Bennett-Corniea, Winifred; Garrison, Warren M. (Univ. of California, Berkeley). Contract W-7405-eng-48. J. Phys. Chem., 71: 772-4(Feb. 1967). (UCRL-17004).

In order to clarify the reaction scheme involved in the radiolysis of $RCONHCHR_2$ in dilute aqueous solutions containing O_2, experiments were conducted using Fe(III) instead of O_2 as the scavenger of intermediate radicals formed in the radiolysis of N-acetylalanine and N-acetylglycine. Results indicate that the reactions of OH and H radicals with these peptide derivatives of the simpler amino acids, glycine and alanine, occur essentially quantitatively at the α position. The data also establish the quantitative oxidation of $RCONHCR_2$ radicals by Fe(III). The low carbonyl yields obtained when O_2 was used in place of Fe(III) as the radical scavenger seem to indicate that other more complex degradation reactions occur in parallel with the dehydrogenation and hydroxylation reactions. (J.G.B.)

14250 ELECTRON EXCHANGE AS EVIDENCED BY ELECTRON SPIN RESONANCE OF COPPER(II) CONFINED IN MOLECULAR SPACE. Fujiwara, Shizuo; Katsumata, Syunji; Seki, Tokuko (Tokyo Univ.). J. Phys. Chem., 71: 115-20(Jan. 1967).

Dipolar broadening and exchange interactions were separately observed in esr spectra of cupric ions which were doped in the molecular space of γ-irradiated polyvinyl alcohol gels. The results obtained in this investigation can be utilized for the elucidation of the number of ions which are contained in the clusters of ions to be produced in frozen solutions. (auth)

14251 ^{60}Co γ RADIOLYSIS OF SOLUTIONS OF POTASSIUM BROMIDE IN 0.8 N SULFURIC ACID. Farhataziz (Univ. of Notre Dame, Ind.). J. Phys. Chem., 71: 598-602(Feb. 1967). (COO-38-461).

The ^{60}Co γ radiolysis of KBr in 0.8 N H_2SO_4 was studied in detail. A mechanism is suggested for deaerated solutions in which O_2 is produced with G = 0.008 and Br^- disappears with G ~ 0.01. It was concluded that $g(HO_2)$ is 0.008 in ^{60}Co γ radiolysis of 0.8 N H_2SO_4 solutions. $G(H_2)$ = 0.38 for bromide solutions in 0.8 N H_2SO_4. The H_2O_2 yields in bromide solutions containing O_2 ~ 300 μM are higher by a few per cent than in the case of aerated solutions. This difference is due to micromolar quantities of CO_2 present in aerated solutions. The k_{H+Br_2} was estimated to be (12 ± 50%) × 10^{10} M^{-1} sec^{-1}. (auth)

14252 PYROLYSIS AND HIGH-TEMPERATURE RADIOLYSIS OF o-TERPHENYL. Scarborough, J. M.; Ingalls, R. B. (Atomics International, Canoga Park, Calif.). J. Phys. Chem., 71: 486-92(Feb. 1967).

The pyrolysis and high-temperature radiolysis (400 to 482°C) of liquid o-terphenyl were studied. The pyrolytic decomposition was found to follow simple first-order kinetics with an activation energy of 71.7 ± 1.3 kcal/mole. The radiolytically induced decomposition occurred with an apparent activation energy of about 22 kcal/mole. The ratio of biphenyl formation to terphenyl disappearance was about 0.35 for pyrolysis but increased with increasing temperature during radiolysis with 1-MeV electrons. A thermal spike model of low LET radiolysis originally derived to explain the radiolysis of toluene at low temperatures is shown to account for the major features of the data. (auth)

14253 X-RAY-INDUCED HYDROGEN-ATOM ADDITION AND REMOVAL IN DIETHYL GLUTACONATE–UREA CRYSTALS. Griffith, O. Hayes; Wedum, Ellen E. (Univ. of Oregon, Eugene). J. Amer. Chem. Soc., 89: 787-9(Feb. 15, 1967).

X-ray-produced free radicals in single crystals of the diethyl glutaconate–urea inclusion compound were investigated by ESR at room temperature. The two long-lived free radicals are $CH_3CH_2OOCCHCH=CHCOOCH_2CH_3$ (I) and $CH_3CH_2OOCCHCH_2$-$CH_2COOCH_2CH_3$ (II). Spectra taken shortly after x-irradiation exhibited a remarkably low relative concentration of the allyl-type radical I. Heating experiments demonstrated that radical I was thermally more stable than radical II and that the two radicals decayed independently. The relative concentration of radical I at 23°C observed after x-irradiation at 77, 273, or 298°K was 20 ± 10%. A table of proton coupling constants is given. (auth)

14254 PRODUCTION OF CARRIER-FREE ^{24}Na BY IRRADIATION OF PURE Mg MATRICES IN POOL REACTORS. Malvano, R.; Rosa, U.; Grosso, P. (SORIN, Centro Ricerche Nucleari, Saluggia, Italy). Energ. Nucl. (Milan), 14: 161-7(Mar. 1967).

Carrier-free ^{24}Na can be produced by irradiating high-purity Mg matrices in the fast-neutron fluxes of pool-reactors. In particular, 13 to 26 mCi ^{24}Na per gram Mg can be obtained for 4-day irradiations in the RS1 reactor. A radiochemical method based on the electrodeposition of the ^{24}Na activity on a Hg cathode was developed: 0.5 g amounts of Mg can be processed in 4 hours, with nearly quantitative recoveries (93 ± 5%) and high decontamination factors from the matrix (1.5 to 5 × 10^3). The procedure is described and the results of some production experiments at mCi level are reported. The specific activity obtained when using 99.99% Mg was found to be in the order of 90 Ci/g, and the radiochemical purity about 99.9%, for 4-day irradiations at 2 × 10^{13} fast neutron/cm^2 s, taking into account a 15-hour decay (treatment and delivery time). (auth)

14255 ELECTRON PARAMAGNETIC RESONANCE STUDY OF L-ALANINE IRRADIATED AT LOW TEMPERATURES. Sinclair, James W.; Hanna, Melvin W. (Univ. of Colorado, Boulder). J. Phys. Chem., 71: 84-92(Jan. 1967).

Single crystals of L-alanine were x-irradiated at 80°K and the electron paramagnetic resonance (epr) of the fragments formed were studied as a function of temperature. The initial fragment formed at 80°K had the unpaired electron localized mainly on the carboxyl group. Upon warming to 140 to 150°K, this initial fragment was quantitatively converted to CH_2CHR (R = COOH), but at a different orientation in the crystal than CH_2CHR formed by irradiation at room temperature. Upon warming to room temperature, a reorientation of the fragment occurred giving the usual room-temperature epr spectrum. An interesting feature about the intermediate fragment is that the methyl protons remained equivalent even when recooled to 80°K. This is in contrast to the room-temperature fragment where the rapid interconversion of methyl protons was frozen out by cooling to 77°K. A mechanism for radiation damage in amino acids is proposed. (auth)

14256 ABSORPTION SPECTRUM OF THE ALLYL RADICAL BY PULSE RADIOLYSIS. Burrell, E. J. Jr. (Loyola Univ., Chicago); Bhattacharyya, P. K. J. Phys. Chem., 71: 774-5(Feb. 1967).

The absorption spectrum of the transient allyl radical was observed in the pulse radiolysis of dilute solutions of allyl bromide in cyclohexane over a 16.0-cm optical path. A preliminary value for its absolute rate constant for termination was obtained. (J.G.B.)

14257 RADIOLYSIS OF CYCLOHEXANE AND A MIXTURE OF CYCLOHEXANE AND BENZENE. Jones, Kent H. (Sandia Lab., Albuquerque, N. Mex.). J. Phys. Chem., 71: 709-11(Feb. 1967). (SC-DC-66-1607).

The higher radiolytic yield of low-molecular-weight hydrocarbons for vapor-phase cyclohexane in comparison to liquid-phase cyclohexane is inferred to be due to the lower vapor density and not due to phase difference. Some of the effects of phase, temperature, and density on the effectiveness of benzene in decreasing the radiolytic hydrogen yield (protection) when mixed with cyclohexane were determined. The abrupt change in hydrogen yield at the critical temperature of cyclohexane in a benzene–cyclohexane mixture is attributed to a difference in the liquid and vapor structures. Protection decreases with increasing temperature and eventually disappears at 315°C. Protection is affected by density in the vapor phase at 285°C; this change in protection is attributed to energy transfer. (auth)

14258 ELECTRON SPIN RESONANCE OF A SIGMA-TYPE RADICAL FORMED BY X-IRRADIATION OF MALONAMIDE. Cyr, N.; Lin, W. C. (Univ. of British Columbia, Vancouver). Chem. Commun., No. 4, 192-3(Feb. 22, 1967).

It has been reported that the ESR spectra of gamma irradiated malonamide crystals exhibit a complex structure of which the major part is due to the $CH(CONH_2)_2$ radical. The remainder of the structure was attributed to a second radical, which was identified as $H_2N \cdot CO \cdot CH_2 \cdot CO \cdot NH$ through a study of the ESR spectra of x-irradiated malonamide and its deuterated analogues. The ESR signal of this second radical disappeared almost completely on annealing at 100°, whilst the intensity of the signal due to the major radical was only slightly changed. The proton nuclear magnetic resonance spectrum of the deuterated compound and hyperfine splittings are discussed. (UK)

14259 REACTION OF FLUORIDE IONS WITH HYDROGEN ATOMS IN AQUEOUS SOLUTION. Anbar, M.; Neta, P. (Weizmann Inst. of Science, Rehovoth, Israel. Soreq Nuclear Research Center, Rehovoth, Israel). Trans. Faraday Soc., 63: 141-6(Jan. 1967).

Fluoride ions reacted with hydrogen atoms to yield hydrated electrons. This was indicated both by decrease in hydrogen

abstraction and increase in the yield of electrons under radiolysis of neutral aqueous solutions. The conversion $H + F^- \rightarrow e^-_{aq}$ also was demonstrated under sonolytic conditions where no e^-_{aq} is originally present. The rate of the $H + F^-$ reaction, $k_{H+F^-} = 1.5 \pm 0.5 \times 10^4\ M^{-1}\ sec^{-1}$, allowed a recalculation of the redox potential of the hydrated electron, $E^0(e^-_{aq}) = 2.5$ V. (auth)

14260 DEGRADATION OF POLY 1,2-CYCLOHEXENE OXIDE INDUCED BY IONIZING RADIATIONS. Cordischi, Dante (Univ., Rome. CNEN, Rome). Ric. Sci., 36: 1029-34(Oct. 1966). (In Italian).

The effect of radiations on poly 1,2-cyclohexene oxide was to induce main-chain scission without cross-linking. The $G_{fracture}$ values for the polymer irradiated in bulk, benzene, and cyclohexane were 8.0, 12.5, and 49, respectively. Degradation of 1,2 cyclohexenedioxide during polymerization induced by radiation was investigated. (auth)

14261 FISSION-FRAGMENT SYNTHESIS OF A NEW NITROGEN–FLUORINE COMPOUND. Miller, Alan R.; Tsukimura, Ray R.; Velten, Robert (Aerojet-General Nucleonics, San Ramon, Calif.). Science, 155: 688(Feb. 10, 1967).

Fission-fragment radiolysis of a mixture of NF_3 and F_2 at room temperature has resulted in the formation of a new, unidentified nitrogen-fluorine compound that is stable at room temperature. (auth)

14262 THEORETICAL INTERPRETATION OF THE SATURATION EFFECT IN IRRADIATED SUBSTANCES. Schoffa, G.; Buerk, G. K. (Technische Hochschule, Karlsruhe, Ger.). Experientia, 22: 856(Dec. 15, 1966).

Theoretical calculation of the dose-saturation effects by irradiation of a compound was investigated using γ rays, x rays, or fast electrons. The mathematical description of this effect is based on the following: During irradiation the radical concentration increases and therefore the average distance between 2 neighboring radicals becomes shorter. If the distance between 2 neighboring radicals is small enough, these 2 radicals can recombine. This recombination depends also on temperature, so that recombination increases with mounting temperature. Equations are presented. (P.C.S.)

14263 RADIATION-INDUCED OPTICAL ABSORPTION IN LEAD BORATE GLASSES IN RELATION TO STRUCTURE CHANGES. Bishay, A. M. (American Univ., Cairo); Maklad, M. Phys. Chem. Glasses, 7: 149-56(Oct. 1966).

A radioinduced absorption band was observed at about 1.5 eV (825 mμ) in lead aluminoborate and lead borate glasses. The effect of increasing PbO content on the 1.5-eV band induced in binary lead borate glasses was examined. The samples were irradiated for 16 hr in an experimental reactor, at a flux ranging from 10^{10} to 10^{12} n/cm^2 sec of thermal neutrons, 10^8 to 10^{10} n/cm^2 sec of epithermal neutrons, 10^8 to 10^{11} n/cm^2 sec of fast neutrons (energy between 3.1-8.2 MeV) and intensity of about 10^7 R/hr of γ radiation (average energy about 2 to 2.15 MeV) by a 6000-Ci ^{60}Co source at a rate of 4×10^5 R/hr. The effect of addition of Ce on the intensity of the 1.5-eV band in glasses melted under various conditions suggested strongly that it is associated with an electron trap near Pb^{2+} ions. The intensity of this band increased with increasing Pb content, reaching a maximum at about 25 mole % PbO. The intensity of the 2.3-eV induced band also increased with increasing PbO, reaching maxima at about 33 and 45 mole % PbO. It is postulated that the changes in intensity observed at about 25, 33, and 45 mole % PbO are associated with structural changes at these compositions. Changes in ir absorption and molar volume supported this postulate. The results indicated that changes in the intensity of the 1.5- and 2.3-eV induced bands may be useful for detecting some structural changes in lead borate systems. (BBB)

14264 RADIATION-INDUCED POLYMERIZATION OF UREA CANAL COMPLEX: PART I. RADIATION-INDUCED POLYMERIZATION OF ACRYLONITRILE IN UREA CANAL COMPLEX. Kawasaki, M.; Maekawa, T.; Hayashi, K.; Okamura, S. (Kyoto Univ.). J. Macromol. Chem., 1: 489-506(July 1966).

The γ-induced polymerization of acrylonitrile in urea adducts was studied. The complete formation of adducts required about 20 hr, and the adducts remained stable below −48°C. The results at −78°C in air showed that the rate of polymerization is accelerated after about 20% conversion and that the initial rate is proportional both to monomer amount and to radiation dose rate. The apparent activation energy of polymerization is 0.62 kcal/mole between −196 and −50°C. The viscosity of polymers, increased with increasing conversion, leading to a maximum value of 60% conversion. The ir spectra of polymers showed that polymerization proceeds by addition of vinyl groups without ketenimine structure. The polymer contains conjugated $(\geq C=N-)_n$ groups, indicating the occurrence of cyclization reaction between nitrile groups after polymerization. It is not certain whether the reaction mechanism is radical or ionic. (BBB)

14265 RADIATION-INDUCED CHANGES IN THE UNSATURATION OF POLYISOPRENE. Golub, Morton A.; Danon, Jeanne (Stanford Research Inst., Menlo Park, Calif.). Rubber Chem. Technol., 39: 992-1007(Sept. 1966).

Cobalt-60 γ radiation and 1-MeV electrons were used to demonstrate that polyisoprene in the solid state and in benzene solution undergoes radiationinduced cis-trans isomerization and loss of unsaturation. Starting with various cis or trans polymers, the isomerization approached an equilibrium in which the cis/trans ratio was around 50/50 for polyisoprenes irradiated in solution or in the solid state. The G values for either cis → trans or trans → cis isomerization, were about 1.0 and 10, respectively. The energy transfer mechanism proposed previously for polybutadiene and sequalene isomerization was assumed to hold for polyisoprene as well. The loss of unsaturation in films irradiated with electrons under nitrogen was twice as rapid as in films γ irradiated in vacuo, the G(−d.b.) (d.b. = double bond) values being 13.4 and 6.7, respectively. Correspondingly, G(−d.b.) for a γ-irradiated solution was 27, calculated in terms of energy absorbed directly by the polymer; intermolecular energy transfer was again indicated, although phenylation may also contribute to the loss of double bonds in solution. The large drop in unsaturation in solution and in the solid state was attributed to a chain process involving cyclization and some cross-linking, with participation of both free radicals and carbonium ions. Work with polyisoprene-3-d confirmed the importance of isomerization and loss of unsaturation and gave an activation energy of 1.1 kcal/mole for the latter reaction. (BBB)

14266 RADIATION INDUCED COPOLYMERIZATION OF BUTADIENE AND SULFUR DIOXIDE. Fujioka, Syuji (Toyo Rayon Co., Ltd., Japan); Hayashi, Koichiro. Kogyo Kagaku Zasshi, 69: 330-4(Feb. 1966). (In Japanese).

Radio induced polymerization under the influence of γ rays from ^{60}Co of a mixture of butadiene and SO_2 was carried out and alternating copolymers were obtained. Observations of the uv spectra indicated the formation of a charge transfer complex of these monomers. The ceiling temperature of this polymerization was estimated to be at 70°C. The reaction proceeds through a radical mechanism. The microstructure of the butadiene unit in the copolymer consists of cis and trans-1,4 configuration, but no 1,2-configuration exists. (NSA of Japan)

14267 RADIATION-INDUCED ORGANIC SULFUR RADICALS AT 77°K. Henriksen, Thormod; Sanner, Tore (Norsk Hydro's Inst. for Cancer Research, Oslo). Acta Chem. Scand., 20: 2888-90(1966).

The ESR spectra of oxidized penicillamine irradiated in vacuum with 220 kV x rays to a dose of 0.5 Mrad was studied. The spectra indicated that the $R\text{-}CX_2\text{-}S^\cdot$ radicals may be formed even at 77°K. When subsequently heat-treated the number of $R\text{-}CX_2\text{-}S^\cdot$ radicals remained constant to about 220°K, whereas on further heat-treatment a significant formation of additional $R\text{-}CX_2\text{-}S^\cdot$ radicals took place. This indicated that in the case of oxidized penicillamine at least two mechanisms were involved in the formation of the $R\text{-}CX_2\text{-}S^\cdot$ radicals. (INIS-Denmark)

14268 EFFECT OF CRYSTAL DIMENSIONS ON THE YIELD OF RADIATION INDUCED RADICALS IN ORGANIC SUBSTANCES. Henriksen, Thormod (Norsk Hydro's Inst. for Cancer Research, Oslo). Acta Chem. Scand., 20: 2898-2900(1966).

Glycine, glycyl-glycine, trypsin, and lysozyme were studied in samples with different crystal dimensions. The samples were evacuated to a vacuum of about 10^{-4} mm Hg and irradiated with 220 kV x rays to a dose of 5×10^5 rad. The ESR spectra were recorded with an x-band spectrometer with 110 kc/sec modulation frequency and indicated that the radical yield increased with decreasing particle dimension. The initial formation of unpaired spins presumably was uniform throughout the crystal when x- and γ-rays were used; this observation suggested that the trapping of ESR centers was more efficient on the surface. (INIS-Denmark)

14269 THE RADIATION-INDUCED FORMATION OF NO_3 IN AQUEOUS SOLUTIONS. Broszkiewicz, R. K. (Inst. of Nuclear Research, Warsaw). Int. J. Appl. Radiat. Isotop., 18: 25-32 (Jan. 1967).

The production of NO_3 by electron pulse radiolysis of nitric acid has been investigated over the concentration range from 10^{-3} to 4.0M HNO_3. The NO_3 transient absorption spectrum has been determined, peaks being found at 595, 635, and 672.5 mμ and probably in the uv below 300 mμ. NO_3 is formed by the reaction $OH + HNO_3 \rightarrow NO_3 + H_2O$ and not by the reaction $OH + NO_3^- \rightarrow OH^-$, consequently no NO_3 absorption was recorded in neutral and alkaline solutions of KNO_3 or in nitric acid at a concentration below

0.05M HNO_3. In neutral and alkaline solutions of KNO_3 a transient absorption at 430 mμ, due to the radical NO_2, has been observed. NO_3 decays by a slow, first-order reaction, the rate constant being $k_3 = (7.59 \pm 0.21) \times 10^3$ sec^{-1}. (auth)

14270 THE ACTION OF ULTRAVIOLET AND X RADIATION ON AQUEOUS SOLUTIONS OF SODIUM PEROXYMOLYBDATE. Wojtezak, Jan (Univ. A. Mickiewiecz, Poznan, Poland); Lassocinska, Aleksandra. Monatsh. Chem., 97: 947-51(1966). (In German).

The effect of uv and x rays on the decomposition rate of aqueous solutions of sodium peroxymolybdate was investigated. The rate of decomposition was followed photometrically at 420 mμ after irradiation with a high-pressure Hg lamp or with 65-kV x rays. Solutions of 0.01M Na_2MoO_6 in 0.1N H_2SO_4 were used. It was found that this system is very sensitive to radiation and decomposes to MoO_4^{2-}, obeying the rate equation of a zero-order reaction. A mechanism for the reaction is proposed and discussed. The following radiolysis pathway is proposed: $MoO_4^{2-} + 2H_2O_2 \rightleftharpoons HM_0O_6^- + OH^- + H_2O$; $MoO_4^{2-} + 4H_2O_2 \rightleftharpoons MoO_8^{2-} + 4H_2O$; and $6M_0O_4^{2-} + 7H^+ \rightleftharpoons HMo_6O_{21}^{5-} + 3H_2O$. (BBB)

14271 ELECTRON SPIN RESONANCE OF Mn^{4+} AND Mn^{2+} IONS IN MgO:Mn, Li AND CaO:Mn, Li AND RADIATION-INDUCED VALENCY CHANGE OF MANGANESE IONS. Morikawa, Masahiro; Azuma, Kenkoku (Mitsubishi Electric Mfg. Co.,Ltd., Japan). Mitsubishi Denki Giho, 40: 1378-83(Sept. 1966). (In Japanese).

Paramagnetic resonance (ESR) absorption of manganese ions, Mn^{2+} and Mn^{4+}, added to MgO and CaO powders with lithium salt was measured at 77°K. Measured g factors, absolute values of hyperfine constants of Mn^{4+} ions and values of Cr^{3+} and V^{2+} having the same electronic configuration, 3 d^3, as Mn^{4+} were compared. The ratio of the cubic field splitting, $\Delta(MgO)/\Delta(CaO)$, for each 3 d^3 ion decreased in the sequence of V^{2+}, Cr^{3+}, and Mn^{4+}. For Mn^{4+} in MgO, red emission due to uv excitation at 77°K was measured to verify nearly linear correlation between emission intensity and peak height values of ESR derivative curve. In the case of CaO hosts, fluorescence was not observed. ESR intensity of Mn showed marked changes depending on uv, x-, or γ-irradiation. The changes were divided into three regions according to the ratio of Li to Mn added. A band model was proposed for the explanation of the mechanism. (NSA of Japan)

14272 THE MECHANISM OF STABILIZING RECOIL ATOMS FROM ^{56}Mn IN POTASSIUM PERMANGANATE SOLUTION. Nesmeyanov, A. N.; Babeshkin, A. M.; Kosev, N. P. Vestn. Moskov. Univ., Ser. II: Khim., No. 4, 51-8(July-Aug. 1966). (In Russian).

On irradiating a $KMnO_4$ solution with neutrons from a Po–Be source (10^7 n/sec), the $^{55}Mn(n,\gamma)^{56}Mn$ reaction takes place. It is proposed that the recoil-activated MnO_4^- ions most probably lose an O^- ion, and form fragments of the type MnO_3, MnO_2^+, MnO^{2+}, and Mn^{3+}, in which the manganese valence differs from the initial valence. Experimental results showed that the addition of filter paper or carrier, a decrease in the concentration of potassium permanganate, an increase in the irradiation time, or an increase in the neutron flux decreased the percentage of ^{56}Mn present in soluble form in solution. At pH > 9 most of the MnO_4^- was reduced to the manganate form MnO_4^{2-}, but at a pH < 9 the MnO_4^- was mostly reduced to MnO_2 and Mn^{2+}. The Mn^{2+} ion can react with MnO_4^- to give MnO_2. The distribution of ^{56}Mn among the different valence forms was estimated as follows: Mn(II) ~ 15%, Mn(VII) ~ 6%, Mn(VI) ~ 38%, Mn(III) [Mn_2O_3 and Mn_3O_4] ~ 25 to 35%, and Mn[IV] ~ 5 to 15%. (TTT)

14273 RADIATION INDUCED COPOLYMERIZATION OF ALLYL ACETATE AND SULFUR DIOXIDE, AND THERMAL DECOMPOSITION OF THE COPOLYMER OBTAINED. Fujioka, Syuji (Toyo Rayon Co., Ltd., Japan); Hayashi, Koichiro. Kogyo Kagaku Zasshi, 69: 334-7(Feb. 1966). (In Japanese).

Allyl acetate, which is hardly homopolymerized because of the degradative chain transfer, is readily copolymerized alternatively with SO_2 under the influence of γ radiation. A charge-transfer complex of both compounds controls the propagating reaction. The rate constant and the activation energy of thermal decomposition were estimated for this copolymer both in air and in vacuum, and it was found that the decomposition mechanism is the so-called "Zipper-type" reaction. (NSA of Japan)

14274 ANNEALING BEHAVIOUR OF LOW-TEMPERATURE NEUTRON-IRRADIATED TRIS-ACETYLACETONE COBALT(III) IN ELECTRON-ACCEPTING (OXYGEN) AND INERT (NITROGEN) AMBIENTS. Sarup, S.; Nath, Amar (Atomic Energy Establishment, Trombay, India). J. Inorg. Nucl. Chem., 29: 299-310(Feb. 1967).

A comparative study of the kinetics of annealing of neutron-irradiated tris-acetylacetone cobalt (III) in the presence of oxygen (air) and in its absence (in nitrogen) was carried out. The characteristic features of the annealing behaviour are interpreted on the basis of the "variable depth electron donors-exchange" model. (auth)

14275 ON THE RADIOLYSIS OF METHIONINE IN AQUEOUS SOLUTION BY GAMMA IRRADIATION. Ohara, Akira (Kyoto Coll. of Pharmacy). J. Radiat. Res., 7: 18-28(Mar. 1966).

Results of quantitative studies of radiosensitivity and radiolytic mechanisms of methionine in aqueous solution exposed to γ irradiation are presented. The products of methionine, methionine sulfoxide, methionine sulfone, α-amino-n-butyric acid, homoserine, homocysteic acid, and homocystine, which were irradiated separately under identical conditions, were studied using an amino acid analyzer. The probable pathways of the radiation decomposition of methionine are discussed. (auth)

14276 DYNAMIC MECHANICAL TESTING TO EVALUATE RADIATION INDUCED CHANGES IN POLYMERS. Traeger, R. K. (Sandia Lab., Albuquerque, N. Mex.). Rubber Chem. Technol., 39: 1268-75(Sept. 1966).

The applications of mechanical spectroscopy, for dynamic mechanical testing of radiation effects on polymers is reviewed. It was concluded that this technique is one of the most useful tools for evaluating effects of radiation on the mechanical and molecular properties of polymers. The application of dynamic testing to specimens in a radiation field is a new approach to radiation effects studies and has great potential. Forty references are included. (J.G.B.)

14277 EFFECTS OF GAMMA RADIATION ON MASTIC SEALANTS. Jackson, B. S.; Akerman, H. E.; Rigg, A.; Welch, M. J. (Evomastics Ltd., Eng.). Nucl. Eng., 12: 117-18(Feb. 1967).

The design of a constant-rate penetrometer by which the properties of mastic sealants can be compared is described. The forces on a probe are measured as it penetrates the sample and from these measurements a characteristic curve is produced. The effects of gamma radiation on the following types of materials are shown: oil base, bitumen base, glazing compound, butyl base, polybutene strip, and butyl strip. (UK)

14278 EFFECT OF γ-IRRADIATION ON THE ENERGY TRANSFER IN THE SYSTEM TOLUENE-2,5-DIPHENYLOXASOLE. Pisarevskii, A. N.; Reznikov, I. V.; Cherenkevich, S. N. Zh. Prikl. Spektrosk., Akad. Nauk BSSR, 5: 789-92(Dec. 1966). (In Russian).

The influence of γ irradiation (at various doses) on the energy transfer at photoexcitation has been studied for solutions of different 2,5-diphenyloxazole (PPO) concentration in toluene. It is shown that energy transfer properties of toluene do not change up to an irradiation dose of the order of 10^7 R. Investigation of the influence of irradiation of separate system components leads to a conclusion about an important role of products of interaction of PPO with toluene, which appear as external quenching in the process of energy transfer. (auth)

14279 EFFECTS OF ENVIRONMENT ON THE RADIATION RESISTIVITY OF TEFLON FIBER. Huang, Hua-Feng. Nashville, Vanderbilt Univ., 1966. 163p.

Thesis.

Effects of environment on the deterioration rate of Teflon when irradiated with either ionizing or non-ionizing radiation were studied. Deterioration rate of Teflon in air was greater than in a vacuum under ionizing radiations. Under ultraviolet radiation, the deterioration rate in oxygen was greater than in nitrogen but less than in vacuum. X-ray diffraction studies were performed to verify the possibility of cooperative effects of radiation dose with environmental pressure. ESR studies of Teflon irradiated under different environments were performed at both room temperature and 77°K. A mechanism was suggested to explain the inhibitive effect of nitrogen atmosphere on the free radical yield during x-irradiation of Teflon. The effects of air on the ESR spectra were also studied. It was concluded that Teflon behaves differently under different radiations. (TSS)

14280 RADIATION-INDUCED REACTIONS IN POLYSTYRENE AND POLYVINYL ACETATE. Graessley, William W.; Alberino, Louis M.; Mittelhauser, Henry M. (Northwestern Univ., Evanston, Ill.). 8p. (CONF-660907-5). DTIE. Gmelin, AED-CONF-66-280-5.

From American Chemical Society Meeting, New York.

In a study of the gamma-induced reactions in polystyrene and poly(vinyl acetate), evidence was found of rapid molecular weight changes at low radiation doses, superimposed on the effects of ordinary random crosslinking and chain scission. The transient reactions appeared to be associated with particular chemical groups within the polymer molecules. (D.H.M.)

Radiochemistry

Refer also to abstracts 14516 and 14990.

14281 A STUDY OF THE CHEMICAL EFFECTS OF β-DECAY FROM ^{132}Te TO ^{132}I USING PAPER ELECTROPHORESIS. Gordon, B. M. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. J. Inorg. Nucl. Chem., 29: 287-91(Feb. 1967). (BNL-10253).

The investigation described utilizes high-voltage electrophoresis for determination of iodine oxidation states resulting from β decay of ^{132}Te as both tellurite and tellurate in aqueous solution. The yield of periodate from basic Te(IV) growth solutions was shown to be negligible and that from basic Te(VI) growth solutions was shown to be significantly smaller than previously reported. The results are discussed in terms of the molecular species of tellurium likely to be present in the growth solutions. (auth)

Separation Processes

Refer also to abstracts 14156 and 14635.

14282 (AEET-265) INVESTIGATIONS ON THE BEHAVIOUR OF PLUTONIUM. Srinivasan, N.; Ramaniah, M. V.; Rao, C. L.; (and others) (Atomic Energy Establishment, Trombay (India)). 1966. 26p. Dep. mn.

The results of experiments carried out on the behavior of plutonium pertaining to: assay of plutonium in aqueous and organic solutions; conditions for the formation of a third phase and recovery of plutonium from it; polymerization and redox reactions of plutonium(IV); and ion exchange purification of plutonium. (auth)

14283 (BNWL-355) DEMONSTRATION OF THE SALT CYCLE PROCESS IN A HIGH-LEVEL RADIOCHEMICAL FACILITY. Bond, W. R.; Jansen, G. Jr.; Mudge, L. K. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1966. Contract AT(45-1)-1830. 77p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The Salt Cycle process for pyrochemically reprocessing UO_2–PuO_2 fuels was studied in pilot-plant equipment. The decladding, dissolution, electrodeposition, and product treatment steps of the process were integrated into a single remotely operable facility. Problem areas for future development were identified, and several kilograms of mixed oxide fuel were recycled to the Plutonium Recycle Test Reactor. The electrodeposition of UO_2–2 wt % PuO_2 from molten alkali chlorides was demonstrated with feed materials irradiated up to 5000 MWd/t. (auth)

14284 (K-L-1780(Pt.17)) ORGDP FUEL REPROCESSING STUDIES PROGRESS REPORT FOR PERIOD ENDING OCTOBER 31, 1966. Smiley, S. H. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Jan. 20, 1967. Contract W-7405-eng-26. 26p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments in scale-up and component and engineering studies are reported. Major emphasis in semiworks operation was the oxidation step in the reactor facility. Other component work included performance testing of filters in volatility process corrosive atmospheres, sampling studies using equipment potentially suitable for large amounts of solids (e.g., to sample the bed of the main reactor), fluidization tests for possible application in separating uranouranic oxide fines from the bed of the main reactor by elutriation, and a long-term run with the ORGDP peripheral compressor. In low enrichment fuel reprocessing, emphasis was placed on the system analysis program; conceptual plant studies, including equipment sizing; and plans to adapt the semiworks plant for interhalogen fluorination. The major reference flow sheet change involves the use of bromine pentafluoride for the production of uranium hexafluoride which is essentially free of plutonium. (P.C.H.)

14285 (K-L-2223) LIQUID CONDENSATION OF A URANIUM HEXAFLUORIDE–BROMINE PENTAFLUORIDE MIXTURE FROM A NONCONDENSABLE CARRIER GAS STREAM. Dunthorn, D. I. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Feb. 1, 1967. Contract W-7405-eng-26. 52p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Two basic designs for a liquid condenser are considered: the flash cooler, in which all condensation heat is removed by precooling the liquid bromine pentafluoride to be added, and the cooled condenser, in which condensation heat is removed partially by flash cooling with the added bromine pentafluoride and partially by gas heat exchange within the condenser. Although these two designs are essentially extensions of one another, they are often treated separately because they require somewhat different design analyses. Design calculations were done using programs for an IBM-7090. Detailed descriptions, along with listings of the computer programs, are appended. (P.C.H.)

14286 (MLM-1353) STABLE GASEOUS ISOTOPE SEPARATION AND PURIFICATION, APRIL–JUNE 1966. Grove, G. R. (Mound Lab., Miamisburg, Ohio). June 30, 1966. Contract AT-33-1-GEN-53. 42p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments are reported for studies on: separation and purification of stable isotopes of rare gases, thermal diffusion research on intermolecular potentials, transport properties, and transport coefficients; and thermal transpiration and superfluid properties of helium. (P.C.H.)

14287 (RT-EC-(66)1) METODO GRAFICO PER LA DETERMINAZIONE DEL COSTO DELL'URANIO ARRICCHITO. (Enriched Uranium Cost: Description of a Graphical Method). (Comitato Nazionale per l'Energia Nuclear, Rome (Italy)). 1966. 5p. (In Italian). Dep. mn.

A graphical method to evaluate the cost of enriched uranium is given. The method allows the costs of feed material and of the separative work to be determined. (auth)

14288 (TID-23663) SOLVENT EXTRACTION AND GAS CHROMATOGRAPHY OF METAL FLUOROACETYLACETONATES. Stokely, James Royal Jr. (Oak Ridge National Lab., Tenn.). May 1966. Contract W-7405-eng-26. 110p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis. Submitted to Clemson Univ., S. C.

The solvent extraction and gas chromatography of metal chelates formed from hexafluoro-2,4-pentanedione and trifluoro-2,4-pentanedione were investigated to provide the basis for improved analytical methods for aluminum, beryllium, zirconium, and hafnium. The decomposition of trifluoro-2,4-pentanedione in basic solution was investigated to determine the acceptable pH range for extraction of metals. Volume changes in extractions with beta-diketones were recognized and examined theoretically. The equations arising from this derivation were verified experimentally for trifluoro-2,4-pentanedione and were used to eliminate sampling errors in extractions with this reagent. Stability constants and partition coefficients (benzene–water) were determined from solvent extraction data. In addition, the extraction of large amounts of metals was studied to provide a suitable method for preparing metal chelates of beta-diketones in a solvent compatible with gas chromatographic systems. Efficient extraction of all the metals was realized with trifluoro-2,4-pentanedione, but extraction of metal complexes with hexafluoro-2,4-pentanedione was low for all conditions used. The gas chromatographic behavior of metal complexes with trifluoro-2,4-pentanedione was studied to find the optimum conditions for analysis. The effect of temperature on the retention volume of the chelates was examined for four columns containing three different liquid phases. Column efficiency was determined for the columns, mixtures of aluminum and beryllium were separated, and beryllium was determined in synthetic solutions by gas chromatography coupled with solvent extraction. Separation and analysis of zirconium and hafnium were not possible under the conditions used because of partial decomposition of the chelates on the chromatographic columns. (auth)

14289 URANIUM: URANIUM METALLURGY FROM ORE TO FUEL. Eng. Mining J., 167: 90-2(Nov. 1966).

Technics of processing and reprocessing U for nuclear reactor fuel are discussed, particularly from an economic aspect. Uranium fuel cycle element costs are expected to decrease by 45% in the decade between 1970 and 1980. Contrary to the expectations of those in mining, a downward trend in concentrate price is $4.50 per lb by 1975 is envisioned. This is on the assumption of improvements in ore recovery, which would more than offset the increased costs forecast for exploration and/or relocation of processing facilities. Reprocessing charges will contribute to the decrease in costs because of additional competitive plants and increased volume. Because of the fuel cycle lag, this business will probably not get build-up until about 1970, but will grow rapidly to a capacity of ~8 Mlb of U by 1980. At this time, costs per pound of contained U will be about $16.50, having dropped from $19/lb in 1970. It is expected that regional plants will also reduce transportation charges. Possible new sources of U and new processing methods are discussed, including the breeder reactor program. (BBB)

14290 SEPARATION OF ^{152}Eu, ^{147}Pm, ^{241}Am, AND ^{246}Cm THROUGH ELECTROPHORETIC FOCUSING USING THE SODIUM POLYPHOSPHATE AS COMPLEXING AGENT. Marcu, Gheorghe. Stud. Univ. Babes-Bolyai, Ser. Chem., 11: No. 2, 61-6(1966). (In Rumanian).

Separation of some rare earths (^{152}Eu, ^{147}Pm) and of some transuranian elements (^{241}Am, ^{246}Cm) between them and between these families, was studied using sodium polyphosphates and the electrophoretic focusing method at a potential difference of ~900 V. The duration of separation was 8 minutes. The best separations were obtained when using sodium polyphosphate of about 0.02 M. In these conditions at pH ~2.45 the ^{152}Eu separated

well from ^{246}Cm and ^{147}Pm from ^{241}Am. The best separation of ^{152}Eu from ^{147}Pm was obtained at pH ~5.50. The ^{246}Cm separated from ^{241}Am only at pH ~7.0, when the distance between their concentration zones was 8 mm. In the presence of europium and promethium the effectiveness of this separation increased to 14 mm. For group separation of the transuranian elements from rare earths the best separation was obtained at pH ~2.45, when the distance between zones was 12 mm. (auth)

14291 SEPARATION OF UO_2^{2+}–^{90}Sr–^{90}Y AND UO_2^{2+}–^{152}Eu THROUGH ELECTROPHORETIC FOCUSING USING THE TARTARIC OR CITRIC ACID AS COMPLEXING AGENT. Marcu, Gheorghe; Lehrer, Conrad. Stud. Univ. Babes-Bolyai, Ser. Chem., 11: No. 2, 67-70(1966). (In Rumanian).

The separation of UO_2^{2+}–^{90}Sr–^{90}Y and of UO_2^{2+}–^{152}Eu was studied by electrophoretic focusing of the ions, using tartaric or citric acid as complexing agents. In tartaric acid 0.5M + NaOH 0.5M, ^{90}Sr separated from UO_2^{2+} and ^{90}Y in pH ~2.0 to 5.0. In these conditions the uranium remained permanently contaminated with ^{90}Y. ^{152}Eu separated very well from uranium. In citric acid 0.5M + NaOH 0.5M, the separation of all components from the system UO_2^{2+}–^{90}Sr–^{90}Y was effected at pH ~2.0 and 5.0. An excellent separation of ^{152}Eu at pH ~2.0 to 5.0 was obtained. The method is applicable to the rapid separation of some fission products of uranium (^{90}Sr, ^{90}Y, ^{152}Eu) as well as to the rapid separation of ^{90}Y from the ^{90}Sr sources. (auth)

14292 TESTING THE JET SEPARATION PROCESS IN A CLOSED CIRCULATION SYSTEM. Schuette, R.; Seidel, D. (Technische Hochschule, Karlsruhe, Ger. Kernforschungszentrums, Karlsruhe, Ger.). Chem.-Ing.-Tech., 39: 80-4(Jan. 24, 1967). (In German).

In the practical application of the jet separation process for separation of uranium isotopes, the elementary separation effect had to be repeated several times by arranging a large number of separating elements in series to form a cascade. A description is given of the construction and testing of a closed circulation system operated by a Roots impeller resistant to corrosion by UF_6, the system comprising the basic unit of a ten-membered pilot cascade at present under construction. (auth)

14293 EXTRACTION OF METALS BY FATTY ACIDS. I. DISTRIBUTION RATIOS OF Fe^{3+}, Al^{3+}, Ca^{2+}, Mg^{2+}, UO_2^{2+}, AND OF SOME FISSION PRODUCTS IN THE EXTRACTION BY PALMITIC ACID AND PARAFFIN MELT. Novak, M.; Havel, A. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). J. Inorg. Nucl. Chem., 29: 531-9(Feb. 1967).

Distribution ratios of macroquantities of iron, aluminum, calcium, magnesium, uranium, and microquantities of ^{137}Cs, ^{90}Sr, ^{90}Y, ^{106}Ru, ^{144}Ce, and ^{95}Zr–^{95}Nb in the presence of 0.1M uranyl nitrate, were studied as functions of the degree of alkalization, i.e. the molar ratio of the base added to the metal salt. Considerable differences in the values of the distribution ratios were found at degrees of alkalization of 0.04 and 2.0 with uranium and zirconium, and compared with the values found for Fe^{3+}, Al^{3+}, Ca^{2+}, Mg^{2+}, and other fission products. (auth)

14294 SELECTIVITY OF CARBOXYLIC ION-EXCHANGE RESIN FOR LANTHANIDE IONS. Arnold, R.; Son Hing, Lynette B. (Univ. of Cape Town). J. Chem. Soc. (A), No. 2, 306-8 (1967).

On a polymethacrylic acid ion exchange resin (Amberlite IRC 50) the selectivity for lanthanide ions was found to increase with decreasing ionic radius. This is the reverse of the order of selectivities found on sulfonic acid resins. Selectivity differences were also greater than on sulfonic acid resins. A polyacrylic acid resin (Amberlite XE 89) showed lower selectivities than the polymethacrylic acid resin. (auth)

14295 SOLVENT EXTRACTION OF PROTACTINIUM, NIOBIUM, AND TANTALUM FROM CITRATE SOLUTIONS. Rigali, L.; Barbano, P. G. (CAMEN, Pisa, Italy). Energ. Nucl. (Milan), 14: 168-71(Mar. 1967).

The extraction of protactinium, niobium, and tantalum from citrate solutions by xylene solutions of a quaternary ammonium compound (Aliquat-336) was investigated. Protactinium is the best extracted and the order of decreasing extractibilities is protactinium, tantalum, niobium; pH strongly affects the extraction of the three elements. Some experiments were done to determine the form of the complex extracted into the organic phase. (auth)

14296 ANION-EXCHANGE BEHAVIOUR OF LIGHT RARE EARTHS IN AQUEOUS METHANOL SOLUTIONS CONTAINING NEUTRAL NITRATES. I. SEPARATION OF CARRIER-FREE LIGHT RARE EARTHS. Molnar, F.; Horvath, A.; Khalkin, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). J. Chromatogr., 26: 215-24(Jan. 1967).

The anion exchange adsorption and separation of the cerium sub-group rare earths were investigated in CH_3OH–NH_4NO_3–IRA 400, CH_3OH–$LiNO_3$–IRA 400, and CH_3OH–$LiNO_3$–Dowex I systems. It was shown that in aqueous methanol solutions of ammonium nitrate the distribution coefficients of the light rare earths were linear functions of the nitrate concentration. On this basis, a simple scheme for the calculation of the probable location of the peaks in gradient elution, as well as a method for the determination of the distribution coefficients by means of gradient elution are presented. (auth)

14297 ANION-EXCHANGE BEHAVIOUR OF LIGHT RARE EARTHS IN AQUEOUS METHANOL SOLUTIONS CONTAINING NEUTRAL NITRATES. II. MACRO–MICRO SEPARATIONS. Molnar, F.; Horvath, A.; Khalkin, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). J. Chromatogr., 26: 225-31(Jan. 1967).

The separating power of methanol solutions containing ammonium nitrate for the separation of trace amounts of light rare earths from macroamounts of adjacent rare earths was investigated. It was shown that anion exchange carried out from methanol solutions of ammonium nitrate provides a useful means for the purification and analysis of the light rare earths. Methods for the purification of gadolinium and for the concentration of light rare earth impurities from gadolinium oxide and gadolinium metal samples are described in detail. (auth)

14298 SEPARATION OF THE RARE EARTHS BY ANION EXCHANGE IN WATER-SOLVENT MIXTURES IN THE PRESENCE OF α-HYDROXYISOBUTYRIC ACID. Faris, John P. (Argonne National Lab., Ill.). J. Chromatogr., 26: 232-8(Jan. 1967).

Adsorption of the rare earths and a few other elements on an anion exchange resin from mixed solvents containing α-hydroxyisobutyric acid was investigated. Elution of the lanthanides was in the order of increasing atomic number. Separation factors between adjacent members of the series were essentially independent of solvent composition and somewhat less in value than analogous cation exchange. Some applications of the system using macro samples were illustrated. (auth)

14299 THERMODYNAMICS OF ION EXCHANGE OF HYDROUS ZIRCONIA. Nancollas, G. H.; Paterson, R. (Glasgow Univ.). J. Inorg. Nucl. Chem., 29: 565-9(Feb. 1967).

Chloride–nitrate, chloride–thiocyanate, and thiocyanate–nitrate ion exchanges on hydrous zirconium oxide were studied at 25°C in solutions of constant ionic strength (0.1 M) and at constant hydrogen ion concentration (0.01 M). Thermodynamic equilibrium constants for the exchange process $RA + B^- \rightleftharpoons RB + A^-$ were calculated using the method of GAINES and THOMAS and are shown to follow the triangle rule, indicating true thermodynamic exchange. (auth)

14300 THE EXTRACTION OF THORIUM FROM NITRIC ACID SOLUTIONS BY DI(2-ETHYLHEXYL)-PHOSPHORIC ACID. Sato, Taichi (Shizuoka Univ., Hamamatsu, Japan). J. Inorg. Nucl. Chem., 29: 555-63(Feb. 1967).

The partition of thorium between nitric acid solutions and solutions of the bis(2-ethylhexyl) ester of phosphoric acid (D2EHPA) in kerosene was investigated. The ir spectra of the organic phases were studied, and the mechanism of extraction is discussed. (auth)

14301 ISOTOPIC MOBILITY AND ITS TEMPERATURE DEPENDENCE IN MOLTEN KCl, RbCl, AND RbBr. Jordan, S.; Klemm, A. (Max-Planck-Institut fuer Chemie, Mainz). Z. Naturforsch., 21a: 1584-91(Oct. 1966). (In German).

The cationic and anionic mass effect in the mobility $\mu+ \equiv \partial \ln bp_+/\partial \ln mp$ and $\mu- \equiv \partial \ln bn_+/\partial \ln m_n$ as well as its dependence on absolute temperature were determined for KCl at 850°C, RbCl at 825°C, and RbBr at 800°C. It is shown that for these three salts not only the mass effect $\mu\pm$, but in three of the four test cases, the reduced mass effect increase with temperature. (tr-auth)

14302 CATION-EXCHANGE BEHAVIOUR OF SEVERAL ELEMENTS IN HYDROCHLORIC ACID–ORGANIC SOLVENT MEDIA. Korkisch, J.; Ahluwalia, S. S. (Univ. of Vienna). Talanta, 14: 155-70(Feb. 1967).

The cation-exchange characteristics of 20 elements towards the strongly acidic cation exchange resin Dowex 50X8 in media containing varying concentrations of organic solvents and aqueous hydrochloric acid were investigated. Based on determination of the distribution coefficients of these elements in the organic solvents methanol, ethanol, n-propanol, isopropanol, methyl glycol, acetone, tetrahydrofuran, and acetic acid, the conditions most suitable for their quantitative separation are indicated and discussed. The elements investigated included U, Th, Zr, Ce, Fe, etc. (auth)

14303 RADIOACTIVE WASTE TREATMENT FACILITIES. 2. Sumiya, Shozo; Muramatsu, Takio (Ebara Mfg. Co., Ltd., Japan). FAPIG (Tokyo), No. 39, 260-2(Jan. 1966). (In Japanese).

The CCP, MISC, and EVAP systems for treatment of radioactive wastes from Japanese power plants are described. The CCP system treats water overflowing from the fuel cooling pond, with capacity of 130 m^3/day. The MISC system also has a similar capacity and treats miscellaneous liquid wastes. In the EVAP system highly radioactive liquid wastes from regeneration of ion exchange towers in the other two systems are treated. The purpose of the MISC system is to remove radioactivities from miscellaneous liquid wastes by the following processes: condensation and settlement, filtration using sands, desalting by mixed bed ion exchange, and filtration by biological filters. Both the CCP and MISC systems employ regenerative-type ion exchange towers, and when they are regenerated, highly radioactive liquid wastes are produced. The EVAP system is installed to treat such liquids, and consists of neutralization tanks, rotary drum driers, condensers, condensate tanks, exhaust fans, solid storages, etc. (NSA of Japan)

14304 ISOLATION OF FISSION PRODUCTS AND THEIR APPLICATIONS. Awwal, M. A. (Univ. of New South Wales, Sydney). Nucleus (Lahore), 3: No. 1-2, 15-18(Jan.-June 1966).

Three different techniques for processing fuel elements for separation of fission products are outlined: the coprecipitation method, the solvent-extraction method, and the ion-exchange method. (M.C.G.)

14305 DEZAKTIVATSIYA SBROSNYKH VOD RADIOKHIMICHESKIKH LABORATORII I EKSPERIMENTAL'NYKH ATOMNYKH REAKTOROV. (Deactivation of Waste Waters from Laboratoires and Experimental Nuclear Reactors). Khonikevich, A. A. Moscow, Atomizdat, 1966. 232p.

Methods used for deactivation of waste waters from radiolaboratories and experimental nuclear reactors are analyzed. The devices and technological design of the installations for waste treatments used in the USSR and abroad are described. Cation, anion, and mixed ionite filters and electrodialysis are described and installation arrangements for deactivation of high-activity (first-cycle reactor waste water) and for low-activity waste water (with 10^{-5} to 10^{-6} Ci/l) are discussed as well as pollution control and personnel dosimetry. Extensive bibliographies are included at the end of each chapter. (R.V.J.)

14306 SEPARATION AND RECOVERY OF BERYLLIUM. Surls, Joseph Pleas Jr.; Becker, Charles Wilton; Mod, William August (to The Dow Chemical Co.). British Patent 1,050,977. Dec. 14, 1966. Filed Sept. 12, 1963.

Beryllium is recovered from acidic aqueous solutions by contacting the solution with a di- or tri-alkylamine in a water-immisicible diluent to remove Fe from the solution, adjusting the pH of the solution in the range of 1 to 5, and extracting the Be from the solution with a mono-or di-alkyl esters of phosphoric acid having from 5 to 19 C atoms in each alkyl group. Fluoride ions can be separated from the solution of Be either before or after the extraction of Fe and prior to the extraction of Be by adding to the solution an aluminum salt, a soluble silicate salt, or an O-containing B salt to convert the free-fluoride ions to complex ions. Alternatively, the fluoride ions can be removed by the addition of a soluble K salt to precipitate the complex fluoride ions prior to the extraction of the Be. (B.L.M.)

14307 REACTOR FUEL PROCESSING. Volume 9, Number 4. Lawroski, Stephen (ed.). One of the five Quarterly Technical Progress Reviews published for the Division of Technical Information, USAEC. Argonne National Lab., Ill., Fall 1966. 64p. GPO $0.70 Domestic, $0.90 Foreign.

A review of reactor fuel processing is presented. Individual abstracts are given for the five areas reviewed. (D.H.M.)

For abstracts of individual sections see: 14308–14311 and 14805.

14308 COMMERICAL ASPECTS OF FUEL PROCESSING. Mecham, W. J.; Jonke, A. A. Reactor Fuel Process., 9: 185-93 (Fall 1966).

The commercial aspects of fuel reprocessing are reviewed; topics discussed are fuel-processing plans, economics of the fuel cycle, and patents available for public use. (D.H.M.)

14309 RESEARCH AND DEVELOPMENT ON AQUEOUS PROCESSING. Reactor Fuel Process., 9: 194-201(Fall 1966).

Dissolution of ThO_2-UO_2 in nitric acid and of Zircaloy in NH_4F–citric acid is reviewed. The feasibility of elutriating ash from burning graphite-matrix fuels in a fluid bed is discussed. Further work on extraction of RuNO complexes is presented, along with information on radiation-damage effects in amine solvent systems. A review of simple low-decontamination aqueous process steps applicable to close-coupled plants indicated little potentiality for operations other than solvent extraction. Application of mixer-settlers to thorium extraction is considered, and a correlation of pulse-column flooding data is presented. (auth)

14310 RESEARCH AND DEVELOPMENT ON NONAQUEOUS PROCESSING. Reactor Fuel Process., 9: 202-24(Fall 1966).

Various types of processes based on the volatility of uranium and plutonium hexafluorides were proposed for processing irradiated reactor fuels. Volatility processes are being applied to both highly enriched fuels and ceramic fuels of low enrichment. In these processes, spent reactor fuels are converted to fluorides, and decontamination is carried out by distillation or sorption–desorption methods. A significant feature of several volatility processes under development for both high- and low-enrichment fuels is the application of fluidization techniques to the direct chemical conversion of fuel materials into gaseous compounds. Alternative processes for the recovery of uranium from fuel materials are the Nitrofluor and the fused-salt volatility processes. Pyrochemical processes are discussed. (auth)

14311 WASTE DISPOSAL. Fineman, P. Reactor Fuel Process., 9: 225-36(Fall 1966).

Treatment of low- and intermediate-level-activity wastes is discussed. Methods considered are ion exchange, electrodeionization, electrodialysis, and incorporation in asphalt. Other topics included are processes for conversion of high-level-activity wastes to solids, final disposal methods, and fission-product recovery. (D.H.M.)

EARTH SCIENCES

Geology

Refer also to abstracts 14327, 14344, 14345, 14410, and 14555.

14312 (BNWL-280, pp 108-10) ION MIGRATION IN HOMOGENEOUS SOIL. Hsieh, J. J. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

A general empirical equation is proposed to describe the ion migration front and the amount of ions carried by infiltrating waters into soil. (auth)

14313 (COO-581-13) ISOTOPIC THORIUM AND ISOTOPIC URANIUM COMPOSITIONS OF MODERN AND FOSSIL MARINE MOLLUSCAN SHELLS. Cheng, Mary Mei-Ling Huang (Washington Univ., St. Louis, Mo. Dept. of Chemistry). June 1966. Contract AT(11-1)-581. 91p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

The thorium-230/uranium-234 dating method was applied to fossil marine mollusks collected from a terrestrial environment. It was found that age determination of fossil marine carbonate by U decay series disequilibrium measurements is applicable to fossil corals and other fossil marine carbonate that formed and remained in a marine environment, but it does not yield consistent results when applied to fossil marine mollusks collected from a terrestrial environment. Experimental data that were obtained on fossil shells from California, Russia, and Greenland are presented. These data are compared with data based on criteria for closed system conditions. Only one sample came near to meeting all criteria. In this sample the absolute age from the thorium-230/uranium-234 ratio agreed with the stratigraphic age. (F.S.)

14314 (STI-PUB-131) GUIDE TO THE SAFE HANDLING OF RADIOISOTOPES IN HYDROLOGY. Safety Series No. 20. (International Atomic Energy Agency, Vienna (Austria)). Nov. 1966. 40p. IAEA: $1.00; Austrian Schillings 26,-; £0.7.1; F Fr 4,90; DM 4,-.

Health and safety aspects involved in the use of radioisotopes in hydrology are presented. Public safety and workers' safety are the bases of the recommendations which are suggested and which are applicable to large-scale investigations of a complex nature or to small-scale investigations. Data are also presented on the applications of radioisotopes in hydrological investigation, such as ground water tracing, river flow measurements, seepage from dams and sediment movement studies. A bibliography containing 54 references is included. (F.S.)

14315 STUDIES ON THE NATURAL ISOTOPIC VARIATIONS OF POTASSIUM: RESULTS, PROSPECTS, AND INTERPRETATIONS. Letolle, Rene (Laboratoire de Geologie Dynamique, Sorbonne, Paris). Geol. Rundsch., 55: 209-16(1966). (In French).

The relative abundances of ^{41}K and ^{39}K were determined in 19 rock samples from Africa, Finland, France, Switzerland, Spain, Greece, and Hawaii. The value of δ_K was found to vary from +8.3% for a sample of dunite from Greece of Jurassic age to −2.6% for basalt from Hawaii representing a contemporary lava flow. The reproducibility of the results was within 2%. The most interesting results concerned the 2 groups of volcanic rocks studied. The mean value for those of the Auvergne series was slightly >0 while the Hawaiian samples were slightly <0. Two explanations are offered to explain the values for the Auvergne samples: (1) fractionation in the course of magmatic differentiation, and (2) mixture of a magma of the basalt type with sialic rocks. The Hawaiian rocks represent a state of differentiation comparable to that in the early crust of the earth, with enrichment in the light isotope. (BBB)

14316 RADIOACTIVITY AND AMBIENT RADIATION. Eugester, J. Naturwiss. Rundsch., 19: 332(Aug. 1966). (In German).

The problem of whether the activity of a well-defined prepared radioactivity standard might be affected by extremely low, but relatively defined ambient radiation if the exposure was protracted enough was studied. A measured UO_3 preparation was divided into 2 parts. One was placed within an Fe casing with 10-cm thick walls, in the Simplon tunnel. The other sample was exposed to cosmic radiation on top of the Jungfraujoch without shielding. The ambient radiation in the Simplon tunnel was $0.2 \pm 3 \times 10^{-2}$ ion pairs/cm^3 of air/sec, and on the Jungfraujoch the average was 20 pulses/cm^3/sec. Measurements were made with an ionization chamber. The samples were placed on the base of the ionization chamber in the center between the internal electrode and the chamber wall, ~3 cm from each. The UO_3 delivered an ionization current with a current equivalent of 1.71×10^{-3} esu/cm^2. At 760 mm pressure at 15°C ~30 particles/sec were emitted by the sample. From sample I, 1.16×10^5 ion pairs were produced along the path of a single α, and for sample II, 1.27×10^5 ion pairs were produced. In relative units the net ionization effect of the first sample was 239.5 ± 2.5 and that of the second was 289 ± 1.8. The results indicated that a standard radioactive preparation does not show the same activity if the ambient radiation represents extreme conditions over a long time interval, possibly because of frequent "fissions" related to cosmic radiation. (BBB)

14317 DETERMINATION OF MINERAL AGE BY THE TRACES LEFT BY URANIUM FISSION FRAGMENTS. Berezina, I. G.; Demidova, P. G. At. Energ. (USSR), 21: 304-6(Oct. 1966). (In Russian).

The mineral age of East Trans-Baikal rare earth deposits, which according to geological data were subjected to prolonged thermal effects following their formation, was studied by the traces of uranium fission fragments and potassium–argon method. The results showed a somewhat lower age obtained by the uranium fission fragment method. The latter was explained by the error in determining the neutron fluxes. Generally, the experiments confirmed the efficiency of the method for determining geochronology of the minerals exposed to high temperature of from 100 to 150°C for a long period. Moreover, the method can be used for determining the age of any minerals on the basis of small amount of collected material even as small as 1 mm^2 of mica. (R.V.J.)

14318 DESCRIPTION OF A NEW METHOD FOR MEASURING THE ATOMIC CONCENTRATION RATIO OF THORIUM AND URANIUM IN MINERALS AND NATURAL GLASSES. PRELIMINARY APPLICATION TO TEKTITES. Bimbot, R. (Faculte des Sciences, Paris); Maurette, M.; Pellas, P. Geochim. Cosmochim. Acta, 31: 263-74(Feb. 1967). (In French).

A new method for the determination of the Th/U ratio in minerals and in natural glasses is described. This ratio was evaluated from measurements of fission-fragment-track densities registered in the mineral after exposure to a known flux of thermal neutrons and high energy protons (85 MeV). Applying this method to some samples of tektites, it was found that the absolute accuracy of the method is of the order of ±25%; however, for a relative comparison of Th/U ratios in samples irradiated simultaneously the uncertainties could be reduced to below ±5%. The advantages of this new method are the rapidity in the determination of the ratio and the small amount (~1 mg) of material required for the analysis. (auth)

14319 ^{26}Al IN PACIFIC SEDIMENT: IMPLICATIONS. Wasson, John T. (Univ. of California, Los Angeles); Alder, B.; Oeschger, H. Science, 155: 446-8(Jan. 27, 1967).

Aluminum-26 has been detected in a sample of sediment from the South Pacific. The disintegration rate of 0.8 disintegration per minute per kilogram of dry sediment is considerably higher than that expected from cosmic-ray spallation of atmospheric argon; it appears to result mainly from accretion of activity induced in interplanetary dust by solar-flare particles. This finding is in keeping with Wasson's published estimates regarding the magnitude of this effect, and confirms the order-of-magnitude correctness of the solar-particle flux and terrestrial accretion rate of interplanetary dust used in that calculation. (auth)

14320 HYDROLOGICAL APPLICATIONS OF RADIOISOTOPES IN AUSTRALIA. Ellis, W. R.; Miles, G. L. (Australian Atomic Energy Commission, Sydney). At. Energy Austral., 10: 2-11 (Jan. 1967).

The use of radioisotopes in hydrology is reviewed, and their use in ground water studies, tracing the movement of water, determining flow rates of rivers, studying sediment movements, and meteorological studies is discussed. Hydrological projects carried out by the Isotope Division of the Australian Atomic Energy Commission over the past six years are listed. A survey of the Commission's research program in this field is discussed. (D.H.M.)

14321 EXTINCT RADIOACTIVITY AND THE DISCOVERY OF A NEW PLEOCHROIC HALO. Gentry, R. V. (Columbia Union Coll., Takoma Park, Md.). Nature, 213: 487-9(Feb. 4, 1967).

The discovery of a new type of pleochroic halo (designated Y), found in Canadian Precambrian biotite with a radius of about 26.5 ± 0.5 μ, is reported. Studies showed that these haloes were produced by alpha particles of approximately 6.55 MeV. The haloes show a

rather light coloration, implying that only a relatively small amount of alpha activity existed originally in the central inclusion, or that partial decay by beta emission occurred. Although it was not possible to identify the parent nuclide of the Y haloes unequivocally, it is thought that ^{211}Bi represents a reasonable choice. What relation, if any, these new haloes bear to the recently reported giant pleochroic haloes is not known. There seems little doubt, however, that the alpha radioactivity responsible for the formation of the giant haloes and the Y haloes corroborates evidence for extinct radioactivity of short half-life previously found in polonium haloes. It is difficult to reconcile these types of extinct radioactivity with current theories of nucleosynthesis and crustal formation. Recent discoveries of haloes in Wolsendorf fluorite further substantiates identification of the Y halo with ^{211}Bi. (UK)

14322 NEW CALCULATION OF THE AGE OF THE ELEMENTS BY THE ^{244}Pu FISSION METHOD. Rowe, Marvin Wayne. Fayetteville, Ark., Univ. of Arkansas, 1966. 60p.

Thesis.

Unambiguous evidence for fission-produced nuclides in meteorites has been shown in the abundance pattern of the xenon isotopes from two samples of the Pasamonte meteorite. The results between the two samples are in excellent quantitative agreement. Calculation of the age of the meteorite from excess fissogenic ^{136}Xe and the uranium content of the meteorite yields a value of 2×10^{10} years, which seems far too large. The result of this calculation leads to the conclusion that part of the fissiogenic xenon in Pasamonte must have been produced by other fissionable nuclide(s), such as ^{244}Pu, in addition to ^{238}U which contributes only about 6% of the excess ^{136}Xe. Evidence is presented against nuclides other than ^{244}Pu as the principal source of the fission xenon. Assuming that the fissiogenic ^{136}Xe in Pasamonte is produced from spontaneous fission of ^{238}U and extinct ^{244}Pu, then Ξ, the time interval between the cessation of nucleosynthesis and formation of the meteorite, is estimated to be ~300 million yr. The largest anomalies ever observed in the mass region 131 to 136 are seen in xenon from Pasamonte. (Dissertation Abstr.)

14323 USE OF NATURALLY OCCURRING ^{14}C TO MEASURE THE PERSISTENCE OF ORGANIC COMPONENTS IN SOIL. Campbell, Constantine Alberga. Saskatoon, Saskatchewan, Univ. of Saskatchewan, 1965. 163p.

Thesis.

Applicability of the carbon-dating method of analysis to studies in soil science was investigated. Factors affecting the accuracy of the method, e.g., precision, isotopic fractionation, bomb produced ^{14}C, "Suess effect," and "de Vries effect," were found to either cause insignificant errors, or errors for which corrections could easily be made. Mean residence times of humus from the A_p horizon of five Saskatchewan soils ranged from 250 years for a Gray-Wooded Podzolic soil to 1000 years for the Black Chernozemic soils. The humus of the Dark Brown Chernozemic soils from Lethbridge, Alberta, was older. It was concluded that the carbon-dating technique, supported by other chemical methods of analysis, is a useful research procedure for resolving problems in soil organic matter investigations. (R.C.K.)

14324 CONCENTRATION DISTRIBUTIONS OF URANIUM, THORIUM, AND SOME ALKALI, ALKALINE EARTH, AND TRANSITION METALS IN THREE CORES OF CONWAY GRANITE, NEW HAMPSHIRE. Brimhall, Willis Hone. Houston, Tex., Rice Univ., 1966. 187p.

Thesis.

Ninety-five samples from three cores of Conway granite of the White Mountain batholith and adjacent Mad River stock were analyzed for concentrations of Li, Na, K, Rb, Mg, Ca, Mn, Fe, Zn, Th, and U. A subset of 52 samples was analyzed for Co, Ni, Cu, and Cd. By megascopic characteristics the samples were placed in subsets of normal, weakly, hydrothermally altered (propylitic), incipiently weathered, diabase-metasomatized, and fine-grained granite having 47, 22, 14, 8, and 4 samples, respectively. Chemical, mineralogical, and field relationships expressed by the fine-grained granite in the cores leads to the conclusion that it is related to the normal granite by processes of magmatic differentiation under influence of tectonic activity. Four measurements of absolute ages of the Conway granite in the White Mountain batholith and adjacent Mad River stock by a newly devised solvent-extraction lead-lead-alpha method (SELLA), a refinement of the lead-alpha method, leads to the conclusion that the Conway granite of the stock is significantly younger than that in the batholith. The results indicate an episodic development of Conway granite with an increase of concentration of radioactive materials as a function of decreasing age. The histograms serve to show the forms of the distribution of concentrations that might be expected in a more thorough sampling and analytical study of the Conway granite. (Diss. Abstr.)

Meteorology

Refer also to abstracts 14663 and 14998.

14325 (BNWL-SA-657) WASHOUT COEFFICIENTS FOR SELECTED GASES AND PARTICULATES. Engelmann, R. J.; Perkins, R. W.; Hagen, D. I.; Haller, W. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 15, 1966. Contract AT(45-1)-1830. 30p. (CONF-660648-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 59th Annual Meeting of the Air Pollution Control Association, San Francisco, Calif.

Precipitation scavenging is the primary cleansing mechanism for airborne gases and fine particulates. Scavenging below cloud base, called washout, acts to remove these from pollution clouds. Advances in radiochemical techniques allow the measurement of such washout coefficients during natural rain and snow. Washout coefficients (fraction washed out per unit time) are presented for several gases as a function of precipitation rate. Deviations from theoretical predictions are discussed. (auth)

14326 (BNWL-SA-1058) EFFECT OF WIND VARIABILITY ON ENVIRONMENTAL CONSEQUENCES OF PROLONGED RELEASES OF RADIOACTIVE CONTAMINANTS. Watson, E. C.; Simpson, C. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 26, 1967. Contract AT(45-1)-1830. 29p. (CONF-670402-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna, Austria.

The environmental consequences of atmospheric releases of radionuclides are approximated by the bivariate normal diffusion model. Vertical growth of the cloud is dependent on the stability of the atmosphere and travel time. Lateral growth is dependent on travel time and related to variations in wind velocity. Diffusion data, using zinc sulfide as a tracer, show that in stable atmospheric conditions the lateral variance term can be best represented as a power function of time. Application of wind variability as a parameter in the model permits a logical extension of time-integrated air concentration calculations to include release times much greater than those used in most experimental studies. The effect of wind variability on environmental consequences is to reduce potential exposures at downwind points of interest. The degree to which these exposures are reduced is dependent upon the rate of release and the dilution rate of the source term. In turn, the dilution rate of the source term is dependent on radioactive decay rate, possible inleakage to the containment vessel and depletion of the contained air-borne material. The model results in a dramatic reduction of calculated distances to the low population zone boundary as defined by the United States Atomic Energy Commission in the Code of Federal Regulations, Title 10 Part 100, i.e., 10 CFR 100. Conversely, for an existing reactor, the model can be used to determine the degree of containment necessary to remain within initial site criteria under which construction of the reactor was permitted. (auth)

14327 (NP-16416) ENVIRONMENTAL RADIOACTIVITY IN NEW ZEALAND AND RESULTS OF EXTENDED MONITORING OF FALLOUT FROM FRENCH NUCLEAR TESTS IN THE PACIFIC. Quarterly Report, April-June 1966. (National Radiation Lab., Christchurch (New Zealand)). 51p. (NRL-F-21). Dep. mn.

Monitoring environmental radioactive contamination in New Zealand and the Pacific areas with which it is associated is reported. Data are included on the following: β activity of air samples near ground level; total amount of β activity of fallout deposited on the ground; ^{89}Sr and ^{90}Sr content in rain; ^{90}Sr and ^{137}Cs content in milk; β activity in air and rainwater; and ^{131}I in milk and cattle thyroids. Age estimation of fission products in air filters was made by measurement of the radioactive decay in these samples. (F.S.)

14328 (NSEC-120) ^{129}I: A NEW ATMOSPHERIC TRACER. Keisch, B.; Koch, R. C.; Levine, A. S.; Roesmer, J.; Winnowski, W. S. (Nuclear Science and Engineering Corp., Pittsburgh, Pa.). Aug. 1965. Contract AT(30-1)-3201. 99p. (NYO-3201-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The requirements for tracers of atmospheric motions are reviewed, particularly with respect to their utility over distances greater than ten miles. The development of tracers incorporating the long-lived nuclide ^{129}I is discussed. The two ^{129}I-labeled tracers, diiodofluorescein and trifluoromethyl iodide, were developed for use as an aerosol and a gaseous tracer, respectively. Detailed descriptions of the methodology for the synthesis, dissemination, collection, and analysis of these tracers are given. The use of ^{129}I as the tracer can result in the extremely high sensitivity and low background required for tracers useful over long distances. High sensitivity is achieved by using specially developed

neutron-activation analysis methods. Low background concentrations result from the fact that there is virtually no naturally occurring ^{129}I. The results of a series of field tests of these tracers showed that the method is sound. Results, essentially in agreement with theoretical predictions, were obtained to distances of 64 kilometers for the aerosol tracer. However, the results for the gaseous tracer were inconclusive due to the inadvertent use of charcoal contaminated with fission-product ^{129}I as the gas sampling media. Calculations, based on assumptions of somewhat improved background levels and reasonable increases in the quantities of ^{129}I released, show that the ^{129}I tracer method can be effective over ranges up to 800 kilometers. (auth)

14329 (RISO-130) ENVIRONMENTAL RADIOACTIVITY IN DENMARK IN 1965. Aarkrog, A.; Lippert, J. (Danish Atomic Energy Commission, Risoe. Research Establishment). June 1966. 99p. Dep. mn.

The methods used for the measurement of fallout radioactivity in Denmark in 1965 are described. Sr-90 was determined in samples of precipitation, soil, ground water, sea water, grass, dried milk, fresh milk, grain, bread, potatoes, vegetables, fruit, total diet, drinking water, and human bone. Sr-90 was determined in local samples of air, rain water, grass, sea plants, animal bone, fish, meat, and human milk. Cs-137 was determined in milk, grain products, potatoes, vegetables, fruit, total diet, pork, beef, and human milk samples, and Cs-137 was measured by whole-body counting in persons from a control group at Risoe. Estimates of the mean content of radiostrontium and radiocesium in the human diet in Denmark in 1965 are given. Results of regular surveys of environmental samples from the Risoe area are included. (auth)

14330 (SC-RR-66-2675) THE ATMOSPHERIC DENSITY EXPONENTIAL, SCALE HEIGHT, AND BASE DENSITY AS A FUNCTION OF ALTITUDE FOR SIX ATMOSPHERIC MODELS. Spahr, H. R. (Sandia Corp., Albuquerque, N. Mex.). Jan. 1967. Contract AT(29-1)-789. 144p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The variation of atmospheric density exponential, scale height, and base density with altitude are presented in tabular form for the following atmospheric models: interim high solar flux day atmosphere; interim high solar flux night atmosphere; interim low solar flux day atmosphere; interim low solar flux night atmosphere; 1959 ARDC model atmosphere, and 1962 U. S. Standard atmosphere. The variation of atmospheric density scale height with altitude is presented graphically for the above models. Four of the six atmospheric density models extend to altitudes of approximately 6 million feet. (auth)

14331 (USNRDL-TR-1100) RADIOCHEMICAL AND PHYSICOCHEMICAL STUDIES OF KIWI-TNT DEBRIS. Lai, John R.; O'Connor, Joseph D.; Crocker, Glenn R.; Pascual, Juan N.; Freiling, Edward C. (Naval Radiological Defense Lab., San Francisco, Calif.). Sept. 28, 1966. Contract AT(49-5)-2505. 136p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Five samples of debris from the Kiwi-TNT event were studied for properties relating to biological hazard: particle properties, radiation properties, radiochemical composition and radionuclide solubility. The samples examined were three cloud samples, one ground-filter sample and a fallout sample. The particles in the cloud and ground-filter samples were in the 10 to 100 micron size range and were mixed with varying amounts of extraneous material (desert dust). In the fallout sample, the bulk of the particles were irregularly shaped, although some spheroids were present. The particles were mainly graphite and the sizes ranged from several microns to several millimeters. Gross gamma decay rates exhibited negative logarithmic exponents ranging from 0.73 to 1.76. The gamma-ray spectra of the three cloud samples were similar, but otherwise significant differences were found from sample to sample. Radiochemical analysis showed that the ground-filter sample was highly enriched in volatilely behaving fission products ($^{89,90}Sr$, ^{131}I, ^{132}Te, ^{137}Cs). The cloud samples were somewhat enriched in volatiles, but relatively representative. The fallout sample showed a depletion of volatiles. This depletion increased as the particle size diminished and as the particle shape became more spheroidal. The fractionation behavior was quite similar to that observed in weapon debris, as was the dependence of fractionation on particle shape. The dependence of fractionation on particle size in the fallout sample, however, was the opposite of that observed in weapon debris and indicates the operation of different fractionation mechanisms. Distilled water, 0.8% saline and 0.1N HCl were tested for their ability to leach activity from the debris. The water and saline solutions were found to have comparable, but low, leaching abilities. The acid had a greater leaching effect than either of these solutions. However, the difference in leaching ability between the acid and other liquids was found to decrease with decreasing particle size. This property was also observed for weapon debris. The soluble activity consisted predominantly of $^{89,90}Sr$, ^{91}Y, ^{131}I, ^{132}Te and ^{140}Ba. (auth)

14332 VERTICAL DISPERSION OF RADIOACTIVE FALLOUT (1963). Nathan, Ami Zvi (Tieraerztliche Hochschule, Vienna). Wien. Tieraerztl. Monatsschr., 51: 541-2(1964). (In German).

Radioactive dust from the air and fallout was collected at 2 sites in 1963. These Weissree at 2348 m altitude and Schneiderau at 1041 m. Both of these are located in the state of Salzburg, 7.5 Km apart. In addition, samples were taken from a location in Vienna. Daily values of long-lived β activity were collected for intervals of from 1.6 to 31.8 hr. Fallout particles were classified in terms of size and relative nuclide composition. The β activity of air particles was measured after collection on filters. The daily values of the activity in the air particles varied widely but similarly between the 2 collecting stations. The radioactivity of the air at the higher station was greater than that at the lower station for 35 days, equal on 4 days, and smaller on 11 days. On the basis of 50 comparative samples there was a decrease of ~18% of the long-lived radioactivity with decreasing altitude of 1300 m. The distribution of radioactivity was similar in all the particles. The radioisotopes ^{141}Ce, ^{144}Ce, ^{95}Zr, and ^{95}Nb were mainly in the particles larger than 5 μ. These were contained in only a few particles smaller than 1 μ, and none was found in particles 1 to 5 μ. Only small amounts of ^{103}Ru were found and were almost equally distributed in particles in size classifications more than 5 μ or less than 1 μ. There did not appear to be any differences related to particle size between the composition of fallout collected at the 2 stations. (BBB)

14333 EFFECT OF DILUTING STACK GASES ON DOWNWIND CONCENTRATION. Bryant, Pamela M. Nucl. Safety, 8: 161-4(Winter 1966-1967).

Examples are given to illustrate the effect on downwind concentration of diluting stack gases before discharge. Dilution alters the efflux velocity and, in the case of hot plumes, the buoyancy, which both change the effective height of discharge. Estimates of resultant downwind concentrations in various weather conditions show that a decrease in effluent concentration by a factor of 3 often produces a reduction of less than a factor of 3 in downwind concentrations. (auth)

14334 INCREASE IN THE TRITIUM CONTENT OF ATMOSPHERIC HYDROGEN SINCE 1960. Ehhalt, D.; Roether, W.; Stich, W. (Univ., Heidelberg). Z. Naturforsch., 21a: 1703-9 (Oct, 1966). (In German).

Measurements of the tritium and deuterium content of atmospheric hydrogen are reported. The measured tritium was corrected for local contamination by industrial hydrogen. The samples cover the period from 1960 to 1965. The tritium content showed a marked increase in 1961 but rose slowly in 1962 and 1963. There is evidence for a further increase in the tritium content starting in fall 1964. The explanation suggested is, that tritiated hydrogen is injected into the high stratosphere by thermonuclear explosions and mixed down into the troposphere with a 2 to 3 years delay. Thus one would ascribe the first increase to 1958 testing, the second to the 1961/1962 thermonuclear test series. (auth)

14335 MEASUREMENTS OF TEMPORARY STANDARD SAMPLE (U_3O_8) AT EACH STATION. TABLE 1. OCTOBER-DECEMBER 1965. Taiki Hoshano Kansoku Seiseki, No. 43, 1-4 (Oct.-Dec. 1965). (In Japanese and English).

The following data on atmospheric radioactivity are presented in tabular form: measurements of temporary standard samples (U_3O_8); summaries of mean radioactivity in rainwater; observed radioactivity of rainwater; observed radioactivity in airborne dusts; ^{90}Sr deposition for the period 1964 to 1965; radioactive measurements of rainwater and falling dusts by gummed paper; and measurements of radioactivity in sea water. (R.C.K.)

14336 PRECIPITATION FORMATION IN A MOUNTAINOUS COAST REGION. Storebo, Per B. (Norwegian Defence Research Establishment, Kjeller, Norway). 24p. (CONF-660556-1; CONF-660557-1). DTIE. Gmelin, AED-CONF-66-263-1.

From 6th International Conference on Condensation Nuclei, Albany and 6th International Conference on Condensation Nuclei, University Park, Pa.

Nuclear bomb debris particles appearing in worldwide fallout, work as excellent condensation nuclei, and this effect has been utilized for tracer studies of extended precipitation systems. Synoptic type and climatological type samples have been examined, and the results strongly indicate that raindrop scavenging of low-level clouds, which have undergone little lifting, is an important mechanism in precipitation formation. For sea level rain in western Norway a mean cloud rise after saturation in the order of 300 meters is indicated. (auth)

Mineralogy

14337 ON THE GEOCHEMISTRY OF URANIUM MINERALIZATION IN THE SWISS ALPS. Huegi, Th. (Univ., Bern). Geol. Rundschau, 55: 437-45(1966). (In German).

The 35 localities in which U has been found in the Swiss Alps are noted on a geological map. Pitchblende is the most important U ore mineral to be found. The ore-containing rocks such as the chlorite and sericite schists and gneisses and the sericite-albite gneisses are metamorphic to varying degrees. The U and Th contents, as well as the content of other metals such as Cu and Pb, and of other accompanying trace-elements, were determined by various analytical methods in samples several tons in size. The results are presented in tables and in a graph. It was found that in mineralized, metamorphic rocks the U content is substantially higher than that of Th. (BBB)

14338 SEISMIC PROSPECTING IN THE ENVIRONS OF URANIUM ORE DEPOSITS AT THE NORTHERN PART OF TOKI CITY GIFU PREFECTURE. GEOPHYSICAL PROSPECTING IN THE TONO AREA. PART I. Hirasawa, Kiyoshi (Geological Survey of Japan, Kawasaki). Chishitsu Chosasho Geppo, 16: 498-512(Sept. 1965). (In Japanese).

Seismic prospecting by a refraction method was performed in the northern part of the city of Toki, Gifu Prefecture, in 1964, where uranium ore deposits had been discovered by a survey made in 1962 by surface radiation monitoring. The purpose of the seismic survey was to investigate the upper boundary of granitic basement at this area. A map shows where the refraction survey was performed. In this area, two velocity layers were obtained. The velocity of the upper layer was 2200 to 2300 m/sec, and that of the basement 4500 to 4750 m/sec. Two channel structures and one saddle structure were found, one monoclinal structure was found. The significance of these refraction zones to the location of the uranium deposits is discussed. (BBB)

14339 ON THE URANIUM IN COAL-BEARING BEDS OF MIKAWA AND AKATANI AREAS, NIIGATA PREFECTURE. Takeda, Eizo; Nochizuki, Tsunekazu; Kaneko, Hirosuke (Geological Survey of Japan, Kawasaki). Chishitsu Chosasho Geppo, 16: 469-97(Sept. 1965).

The distribution of uranium in some Japanese coal-bearing beds is described. Correlation between the contents of uranium and organic materials and the relation between uranium and other minor elements are discussed. The uranium contents of 131 samples in Mikawa and Akatani areas ranged from 2 to 450 ppM U_3O_8. Uranium is more concentrated in coal shales and coal mudstones, which have higher ash contents than in the high-grade coal. To investigate the dependence of uranium contents upon the amounts of ash and organic matter present in the coal samples, the contents of ash and uranium in each fraction of the samples, which was classified by differing sp gravities, were determined. The uranium contents were not always proportional to the contents of organic materials. Minor elements such as vanadium, gallium, copper, molybdenum, chromium, tungsten, and nickel seem to be associated with the occurrence of uranium. (BBB)

Oceanography

Refer also to abstract 14335.

14340 (TID-23476) STUDIES OF BACKGROUND RADIOACTIVITY LEVELS IN THE MARINE ENVIRONMENT NEAR SOUTHERN CALIFORNIA. Report No. IMR-TR-922-66-A. Folsom, T. R. (Scripps Institution of Oceanography, La Jolla, Calif. California Univ., La Jolla. Inst. of Marine Resources). Nov. 1, 1966. Contract AT(11-1)-34. 43p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Pacific coastal background radioactivity levels in the area of Southern California that may be changed by an expanding population and increased use of radioisotopes and nuclear power are studied. Sewage, sludge and dried fertilizer from the Los Angeles Hyperion Plant were monitored for γ-emitting radioisotopes. Samples from 8 other city sewage plants were also monitored. The marine environments near Point Arguello and the Pacific Ocean near the California coast were monitored for fallout and debris from SNAP devices. (F.S.)

ENGINEERING

Nuclear Explosions

Refer also to abstract 14363.

14341 (AD-643170) TRANS-ATTACK AND POST-ATTACK COMMUNICATIONS REQUIREMENTS FOR FIRE-FIGHTING OPERATIONS AND CONTROL. Final Report. Spencer, Victor H.; Price, Harold E.; Siciliani, Frank A.; Howard, Walter J.; Korn, Barry (Serendipity Associates, Chatsworth, Calif.). June 1966. Contract N228(62479)69222. 171p. (TR-33-66-19; USNRDL-TRC-50). CFSTI $3.00 cy, $0.65 mn.

A systems analysis to determine the trans-attack and post-attack communications requirements for fire-fighting operations and control during a hypothetical nuclear attack on a metropolitan area is reported. Communications functions within the metropolitan fire department were derived, and insofar as possible, the interdepartmental communications functions with interacting agencies in the disaster network. The types of information communicated, and the volume and frequency of messages were delineated. From these data a traffic model was developed and queuing theory was applied to evaluate the effects of specific communications and organizational parameters against traffic criteria. It was concluded that (1) for large attacks the communication requirements are a function of the number of fire-fighting units rather than the number of fires; (2) three channels of communication are adequate to serve approximately 200 fire-fighting units if only significant information is communicated, and if the through channels are shared; (3) redundant communications can be reduced by decentralizing decision centers in the fire department organizational structure. (auth)

14342 (NRDL-TRC-56) DESIGN OF TEST FOR SIMULATING URBAN AREA BURNS. Final Report. Salzberg, F. (IIT Research Inst., Chicago, Ill.). June 1966. 60p. CFSTI $3.00 cy, $0.65 mn.

The requirements for simulating urban area burns by means of crib fires or other synthetic type fires was determined. Particular attention was given to the mass fire problem to be investigated during Operation Flambeau. The literature revealed only a limited amount of pertinent information. Existing data pertain primarily to fires unaffected by interactions with other fires or by fire-induced changes in the environment. Wood-crib fires were found to be the most extensively used for studying building burns, but reported experimental results are not sufficient for relating behaviors of crib and building fires, particularly in the environment of a mass fire. An experimental program for obtaining this information has been outlined. (auth)

14343 (ORNL-TM-1714) SURVEY OF UNDERGROUND UTILITY TUNNEL PRACTICE. Boegly, W. J. Jr.; Griffith, W. L. (Oak Ridge National Lab., Tenn.). Feb. 1967. Contract W-7405-eng-26. 118p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A survey has been conducted on the use of underground, walk-through tunnels for utility systems. Results of this survey indicate that this concept has been successfully and extensively employed at universities and Government installations but is not commonly used in cities. There appears to be no set criteria or design for utility tunnels, and an optimization of the parameters is needed. Since many parallels exist between institutions and expected urban renewal projects, extrapolation of the utility tunnel concept to these projects appears worthwhile. Modifications to utility tunnels to incorporate civil defense shelter space appear possible, but further design studies are required. (auth)

14344 (PNE-1101) SITE-SELECTION INVESTIGATIONS. PROJECT PRE-GONDOLA. Jack, H. A. (Army Engineer District, Omaha, Nebr.); Dudley, W. W. (Army Engineer Nuclear Cratering Group, Livermore, Calif.). Feb. 1967. Contract W-7405-eng-48. 45p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Site selection investigations are described for Project Pre-Gondola, a U. S. Army Engineer Nuclear Cratering Group chemical explosive cratering experiment in weak, saturated shale. The investigation was begun in January 1966 and concluded in June 1966 with the selection of an area adjacent to the Fort Peck Reservoir in northeastern Montana. In addition to an office study covering the U. S. and field reconnaissance of 14 sites, subsurface investigations with accompanying laboratory tests were conducted at the primary site and one alternate site near Edgemont, South Dakota. A second alternate site was considered at Cedar Ridge in Crook County, Wyoming, but no subsurface investigations have been conducted. The medium present at the Fort Peck site is the Bearpaw shale, a highly compacted, uncemented clay-shale of Cretaceous age. The laboratory unconfined compressive strength of the intact shale is as great as 500 psi, but the in situ field strength is reduced by bentonite seams and an extensive system of jointing and slumping. The medium is saturated, but its permeability is so low that free water is available to observation wells only where the shale is highly jointed. The site provides a variety of terrain conditions which make it suitable for all phases of the experiment, including a row crater in varying terrain. (auth)

14345 (UCRL-50149) MACRODEFORMATION RESULTING FROM THE HANDCAR EVENT. Boardman, Charles R.; Meyer, G. Lewis; Rabb, David D. (California Univ., Livermore. Lawrence Radiation Lab.). Dec. 1, 1966. Contract W-7405-eng-48. 54p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The Handcar event was a 12-kt nuclear explosion at a depth of 402.3 m in fractured dolomite. The explosion produced a cavity with a radius of 21.2 ± 0.8 m which collapsed within 17 seconds after the detonation. The resultant chimney of broken rock is slightly tilted and extends to a height of 68 m, or 3.2 times the cavity radius above the shot point. A void exists at the chimney apex with a height of 17.4 m and volume greater than 50% of the initial cavity volume. Rubble particles observed on the floor of this cavity range up to 1 m in diameter. 82% by volume of the observed particle diameters are in the range of 2.5 to 42.5 cm. The rock below the chimney appears to be highly crushed to a radial distance from shot point of 26–27 m. Also, data from the pressurization of the chimney are interpreted to indicate that the average permeability of the rock beyond the chimney has been increased to a radial distance of 3.5 to 5 cavity radii. The air temperature in the apical void of the chimney was 34.5°C (10°C above background) 12 months after the explosion. The first indication of a temperature rise above background was observed at a radial distance of 113 m above the shot point. The maximum observed radial extent of increased gamma radiation above background was about 94 m above the shot point. (auth)

14346 (UCRL-50150) A MEASUREMENT OF THE VOLUME OF VOID IN THE SHOAL CHIMNEY. Boardman, Charles R. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 27, 1966. Contract W-7405-eng-48. 12p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Air pressurization tests conducted on the Shoal chimney indicate a chimney void volume of $80{,}400^{+1400}_{-1400}$ m³. Assuming that the cavity was spherical at time of collapse and that all its void was translated into the chimney, its radius was $26.8^{+0.3}_{-0.5}$ meters based on this measurement. This value is consistent with an interpretation of temperature data from the region below shot point. (auth)

14347 ELECTRON MICROPROBE ANALYSIS OF FALLOUT PARTICLES. Mamuro, Tetsuo; Fujita, Akira; Matsunami, Tadao (Radiation Center of Osaka Prefecture). Health Phys., 13: 197-204(Feb, 1967).

Electron microprobe analysis has been made on the highly radioactive fallout particles which originated from the first Chinese nuclear test explosion that was carried out on the land surface. Eight elements, Fe, Ca, Si, Al, K, Mn, Ti and P were confirmed to be present in the particles. It was found that the four elements, Fe, Ca, Si and Al were the main constituent metallic elements and that the darkness of particle color increased with the Fe concentration. X-ray scanning images taken on several particles suggested that in some particles these elements were distributed rather heterogeneously. According to the results of electron microprobe analysis obtained formerly on the highly radioactive fallout particles which originated from a large scale air burst carried out by the U.S.S.R. in autumn 1962, the constituent metallic elements of these particles were Fe, Al and Si, and these elements seemed to be quite uniformly distributed in the particles. The differences in the kind and distribution of the elements between the Chinese and the Soviet particles are ascribed to the differences in burst conditions. (auth)

Facilities and Equipment

Refer also to abstracts 14330, 14929, and 15053.

14348 (ANL-7088) SAMPLING OF LIQUID METALS. Winsch, I. O.; Tobias, K. R.; Pierce, R. D.; Burris, L. Jr. (Argonne National Lab., Ill.). Sept. 1965. Contract W-7405-eng-38. 17p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Methods and devices for obtaining both filtered and unfiltered samples of a metal solution containing insoluble material are described. Reasons why filtered samples are often necessary

and precautions required during sampling are discussed. Evidence that establishes the reliability of the sampling methods described is presented. (auth)

14349 (MTI-66TR66) PROCEEDINGS OF THE TECHNICAL MEETING ON SUPER-LAMINAR FLOW BEARINGS AND SEALS FOR PROCESS-FLUID LUBRICATED TURBOMACHINERY, NOVEMBER 1 AND 2, 1966, ALBANY, NEW YORK. Arwas, E. B. (ed.) (Mechanical Technology Inc., Latham, N. Y.). Dec. 1966. Contract AT(30-1)-3363. 490p. (NYO-3363-6; CONF-661112). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Seventeen papers on the development of super-laminar flow bearings and seals for process-fluid lubricated turbomachinery are presented. Individual abstracts were prepared for eight papers. The remaining papers contain information on lubricating films, fluid flow, and future equipment which may use these bearings and seals. (L.C.L.)

For abstracts of individual sections see: 14350—14357.

14350 (MTI-66TR66, pp 2.1-4) REVIEW OF THE ROLE OF THE ATOMIC ENERGY COMMISSION IN PROCESS-FLUID LUBRICATION. Grossman, Nicholas (Division of Reactor Development and Technology (AEC), Washington, D. C.).

The role of the Atomic Energy Commission in process-fluid lubrication is briefly reviewed. The practical advantages of gas lubrication were recognized in the early 1940's in AEC work. The continued development of reactors in the United States and Europe had demonstrated the need for increasing the knowledge of process-fluid lubrication technology. Gas, water, and liquid metals for bearing fluids are being investigated. An alkaline liquid metal bearing and seal system should be developed for future reactors. (L.C.L.)

14351 (MTI-66TR66, pp 3.1-36) PROCESS-FLUID LUBRICATION OF TURBOMACHINERY BEARINGS. Arwas, E. B. (Mechanical Technology Inc., Latham, N. Y.).

Includes Appendix by E. B. Arwas and W. D. Waldron.

Process-fluid lubrication is being increasingly specified for closed cycle, high speed and high temperature (as well as cryogenic) turbomachinery applications. This is being done to preclude oil contamination of critical system components, to permit bearing operation at the system temperatures, to minimize sealing requirements and for other similar reasons. The use of process-fluid lubrication, however, requires some fundamental changes in mechanical design to cope with the limitations of many cycle fluids when used as lubricants. These design considerations include the effects of turbulent flows in the bearing gap, bearing stability, reduced bearing damping and ultimate load capacity, oxide deposition, selection of compatible bearing materials and surface coatings, potential pivot fretting and others. The advantages, problem areas, and design approaches that have been used in current process-fluid lubricated machines are discussed. (auth)

14352 (MTI-66TR66, pp 6.1.1-33) EXPERIMENTS WITH HYDRODYNAMIC JOURNAL BEARINGS OF VARIOUS MATERIALS AND DESIGNS IN SODIUM AT TEMPERATURES TO 800°F. Schuller, Fredrick T.; Anderson, William J.; Nemeth, Zolton (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center).

Experiments were conducted with 1.5 inch diameter hydrodynamic journal bearings in liquid sodium at 500 and 800°F, speeds to 12,000 rpm and unit loads to 31 psi. The stability characteristics of four different geometries and the wear and seizure properties of several material combinations were investigated. Tilting pad bearings were most stable. Combinations of a cobalt alloy with nickel alloys or with a titanium carbide cermet showed the best wear and seizure properties. (auth)

14353 (MTI-66TR66, pp 6.2.1-46) ALKALI METAL BEARING AND SEAL DEVELOPMENT AT SPACE POWER AND PROPULSION SECTION. Schnetzer, E. (General Electric Co., Cincinnati, Ohio. Space Power and Propulsion Section).

Includes Appendices A through E.

Three major programs associated with the development of a Rankine cycle power conversion technology for space application were undertaken: low viscosity bearing stability investigation, development of dynamic seals, and preparations for a liquid metal loop testing test, simulating the conditions of a space generator. All programs were supported by a corresponding analytical effort, presently geared towards predicting bearing/rotor response. Experimental results are expected in 1966, and 1967. Screw seals, rotating channel and slinger squeeze seals were investigated in the dynamic seal program. Interface instability was identified as one of the major problems. It was resolved for the case of the slinger squeeze seal, which was successfully tested in potassium. (auth)

14354 (MTI-66TR66, pp 6.3.1-26) BEARING AND SEAL MATERIALS FOR LIQUID METAL LUBRICATION. Murray, S. Frank (Mechanical Technology Inc., Latham, N. Y.).

Flame and plasma-sprayed hard coatings for bearing and seal components of process-fluid lubricated bearing systems are evaluated. The effectiveness of some of these coatings in protecting the surfaces against sliding damage in inert environments has been demonstrated in a number of practical applications. All of the test results show that these coatings can also be used effectively for liquid metal-lubricated systems. The coatings simplify the design and fabrication of the bearing and seal components, but have the disadvantage of lack of adequate quality control. Necessary quality control procedures for the use of coatings must be developed to ensure a reliable product. (L.C.L.)

14355 (MTI-66TR66, pp 7.1.1-34) BEARING SHAFT SYSTEM DYNAMICS: MERCURY RANKINE EXPERIENCE AT TRW. Kasuba, R. (TRW Inc., Cleveland, Ohio).

The mercury lubricated bearing system of the SNAP-2 turbo-alternator units involving a flexible rotor and operation in the nonlaminar flow regime was investigated for dynamic qualities and responses. The design and development of the rotor-bearing system was adjusted as empirical data was obtained. Satisfactory correlations between the predicted and measured responses of the system were obtained. The dynamic quantities of the selected three-pad bearing may be characterized by high damping capacity and wide regions of stable operation. Critical damping factors of about 0.25 to 0.50 were exhibited. The bearing provided sufficiently large stability regions for a selection of pressures and geometric parameters. (L.C.L.)

14356 (MTI-66TR66, pp 8.1.1-6) BEARING AND SEAL REQUIREMENTS FOR LARGE LIQUID-METAL COOLED REACTOR SYSTEMS. Dickenson, Robert W. (Atomics International, Canoga Park, Calif.).

The requirements of bearings and seals in pumps for high power output liquid-metal cooled reactors are outlined. Present and potential uses of sodium lubricated bearings are described. The need for a reliable, economical seal for mechanisms in sodium-cooled reactors is emphasized. (L.C.L.)

14357 (MTI-66TR66, pp 8.3.1-22) PROCESS FLUID LUBRICATED BEARINGS FOR HIGH-TEMPERATURE GAS-COOLED REACTOR CIRCULATORS. Yampolsky, J. (General Dynamics Corp., San Diego, Calif. General Atomic Div.); Wilcock, D. F. (Mechanical Technology Inc., Latham, N. Y.).

The development of a new gas-cooled power reactor, has required the engineering of a new steam-driven, high-pressure, helium circulator. Because of the simplifications possible in seals and lubricant systems, water lubricated bearings were selected. A shrouded step design was chosen for both journal and thrust bearings. These designs offer the advantages of a large tolerance to wear, no moving parts, and the flexibility of running as hybrid or even hydrostatic bearings if desired. An approximate solution, accounting for turbulence effects (the Reynolds Number may exceed 25,000) has guided initial design. Some results from a computer solution for the thrust bearing taking into account inertial effects as well as turbulence are described. (auth)

14358 (N-66-39971) SNAP-8 ELECTRICAL GENERATING SYSTEM DEVELOPMENT PROGRAM. Semiannual Progress Report, July 1-December 31, 1965. Report 3137. (Aerojet-General Corp., Azusa, Calif.). Mar. 1966. Contract NAS5-417. 241p. (NASA-CR-72085). CFSTI $3.00 cy, $0.65 mn.

SNAP-8 is a turboelectric, nuclear, space power conversion system using a mercury Rankine cycle. The system incorporates three liquid metal loops. Sodium-potassium (NaK) in the primary loop is heated in a reactor, and in turn heats mercury in a heat exchanger. The mercury vapor, in the second loop, expands through a turbine; it is then condensed and pumped back through the boiler. A third loop, also containing NaK, transfers the heat from the mercury to a radiator where it is rejected to space. The fourth loop contains a polyphenyl ether that lubricates the bearings of the main rotating components and provides necessary cooling for the alternator, electric motors, and controls. This report covers the progress in development of the SNAP-8 power conversion system and system components during the last half of 1965. (STAR)

14359 (NP-16386) ANNUAL REPORT TO THE DIRECTOR-GENERAL FOR THE YEAR ENDED JUNE 30, 1966. (Commonwealth X-Ray and Radium Lab., Melbourne (Australia)). 1966. 32p. Dep. mn.

Activities of the Commonwealth X-Ray and Radium Laboratory are reviewed for the period ending June 30, 1966. These activities include the supervision of the program for lending radium and radon to hospitals and research centers; the development, modification, and application of equipment for radiation dosimetry, advisory services on technical aspects of diagnostic x-ray equipment; advisory services on physical aspects, including safety, in the use of radioisotopes, radiological investigations; and film badge monitoring services. An important development during the year was the formal appointment of the Director as an agent authorized to estab-

lish and maintain national standards for the measurement, in terms of the Curie (Ci), of the activity of radioactive substances and for the measurement, in terms of the roentgen (R), of exposure to x rays. (F.S.)

14360 (RT-ING-(66)-8) SAFETY ASPECTS OF IRRADIATION EXPERIMENTS. Gerosa, A.; Moretti, S. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 10p. Dep. mn.

A general method of dealing with the safety aspects in designing and testing irradiation devices is proposed. The safety analysis should be made on a rational quantitative basis, taking into account economic factors and failure probabilities. The method of analysis can also be applied in nonnuclear fields. (auth)

14361 (SC-RR-66-589) ROVER/PHOEBUS SCALED MODEL CHEMICAL EXPLOSIVE DESTRUCT TEST RESULTS. Berry, R. E. (Sandia Corp., Albuquerque, N. Mex.). Dec. 1966. Contract AT(29-1)-789. 55p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The ROVER/PHOEBUS scaled model tests were performed to evaluate the safety aspects of nuclear power supplies being proposed for space application. Three tests were performed to provide base level or comparative data about the destruct event under controlled conditions. Data about the debris cloud shape, metallic parts distribution, and graphite particle size distribution were collected from these tests. Future testing to determine the effects of nonsimultaneous firing of the explosive charges, varying the explosive entry angle into the core, and destroying the model with the core heated to near reactor operating temperature were delayed pending a redirection of the program when the results from the control tests indicated that with the present explosive weight, perturbations would not be observable. During the delay period, the explosive destruct mode of disposal became less attractive, and the test program was canceled. (auth)

14362 (TID-23648) NES/ETS-1 DUCT STRUCTURAL DYNAMICS. NERVA PROGRAM. (Aerojet-General Corp., Sacramento, Calif.). Aug. 1965. Contract SNP-1. 108p. (RN-S-0211). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The final structural dynamics analysis of the Nuclear Exhaust System (NES) duct for the Engine Test Stand No. 1 (ETS-1) at NRDS is presented. The duct assembly is designated SST-2, subsonic turn configuration. Using digital computer techniques, structural vibration modes and natural frequencies of the exhaust duct assembly were obtained. Dynamic stresses along the duct section under full scale nuclear (NERVA) engine operation were calculated. As a result of this analysis the structural dynamic integrity as well as the overall structural design stability has been proven to be adequate for the NES for ETS-1. (auth)

14363 (UCID-15034) POSTSHOT DRILLING HANDBOOK. Johnson, Walter H.; Cramer, Jim; Thompson, Bobby; Sitko, Wally (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 1966. Contract W-7405-eng-48. 55p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Equipment and techniques used in postshot drilling to obtain data on the results of underground nuclear tests are described. Postshot drilling, which is a specialized application of rotary drilling, is used in recovering radiochemical samples from underground nuclear test shots; providing information on cavity size and chimney dimensions; determining shot effects on surrounding materials; and to study the distribution of radioactivity in the shot zone. Drilling situations and methods used at the Nevada Test Site, detailed information on special equipment and techniques, and the breakdown costs for typical postshot drilling operations are described. (F.S.)

14364 (WCAP-3690-1) DEVELOPMENT OF A BORON CONCENTRATION METER. Technical Progress Report for the Period Ending September 30, 1966. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Oct. 1966. Contract AT(30-1)-3690. 25p. (EURAEC-1722). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States-Euratom Joint Research and Development Program.

In the development of a boron concentration meter, laboratory tests were carried out on the effects of fructose, mannitol, and glycerol on the conductivity of boric acid solutions. After conductivity tests, glycerol was eliminated from further testing because of comparatively low effectiveness in increasing conductivity. Further research and calculations were carried out with fructose and mannitol in regards to temperature dependence, measurement accuracy, and system conceptual design. It was concluded that, although the delay time criteria probably can be met, accuracy requirements may be difficult to achieve on an in-line instrument, and operational costs will be significant. (F.S.)

14365 (ORNL-tr-1568) PRESTRESSED CONCRETE REACTOR PRESSURE VESSELS FOR 100 atm INTERNAL PRESSURE. Dorner, Heinrich; Guhl, Harald. Translated for Oak Ridge National Lab., Tenn., from Tech. Ueberwach., 7: 10-16(1966). 26p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $2.60 fs, $0.98 mf.

The advantages and disadvantages of prestressed pressure vessels for reactors are discussed in relation to steel pressure vessels. From the standpoint of operating reliability, the use of prestressed concrete vessels offers certain advantages for sizes in which shop assembly of a steel vessel is not possible. A prestressed concrete pressure vessel 7.5 m ID for use at 100 atm internal pressure is described. A 1:3 scale model is under construction. The experimental program to be conducted with the vessel is outlined. (F.S.)

14366 GROOVED METALLIC SEAL FOR HELIUM PRESSURE VESSEL. Bula, K.; Jenni, H. P. Nucl. Eng., 12: 119(Feb. 1967).

The design of a seal for inspection windows on the Dragon reactor charge-discharge machine is described. Anticorodal A was used as the seal material for the design conditions (27kg/cm^2, 50°C). The stressing of the seal is discussed. (UK)

14367 STANFORD LINEAR ACCELERATOR COMPONENTS (Engineering Materials). (Stanford Linear Accelerator Center, Stanford Univ., Calif.). (CAPE-1535).

3 drawings.

Three components, the thin valve, the beam scraper, and the beam monitor for the Stanford Linear Accelerater are described. The beam scraper and monitor serve to shape and control the electron beam. The thin valve closes the accelerator disc-loaded waveguide to conserve the vacuum. (For details see TID-4100 Suppl. 39.) (F.S.)

14368 CENTRIFUGAL PUMP, MODEL LFB (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1543).

49 drawings.

A sump-type centrifugal pump designed for pumping high-temperature liquid is described. The model LFB pumps 5 gpm at a 92 ft. head at a speed of 6000 rpm. The fluid pumping power for NaK at 1200°F is 0.1 hp and for $LiF-BaF_2-UF_4$ it is 0.3 hp. The pump has freedom from altitude restrictions and has been tested in reactor experiments and heat exchanger-radiator experiments. (For details see TID-4100 Suppl. 39) (F.S.)

14369 ARGON BOX (Engineering Materials). (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). (CAPE-1540).

26 drawings.

Modifications to provide a glove box with an argon atmosphere are described. The modifications include the pump enclosure, control console, and piping designs. The pump enclosure is mounted beneath the glove box. The enclosure contains the High Vac Duo Seal Pump, absolute filter, and dust stop filter. The piping system is used to supply the Ar atmosphere to the box. The control console controls the pump and the Ar atmosphere. The box is located in the Dry Chemistry Facility. (For details see TID-4100 Suppl. 39) (F.S.)

14370 ACTINIDE RESEARCH FACILITY (Engineering Materials). (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). (CAPE-1542).

56 drawings.

Modifications and new designs for the Actinide Chemistry Research Facility are described. Glove boxes were modified and water shield tanks installed. (For details see TID-4100 Suppl. 39) (F.S.)

14371 AEROSPACE FLUID POWER SYSTEMS AND EQUIPMENT CONFERENCE, LOS ANGELES, CALIFORNIA, MAY 18-20, 1965. SAE Conference Proceedings. New York, Society of Automotive Engineers, Inc., 1965. 477p. $20.00. (CONF-650580).

Fifty one papers are presented on aerospace fluid power systems and equipment. A separate abstract was prepared for one paper. The remaining papers contain information on fluid power systems for Saturn-Apollo, supersonic transport hydraulic systems, subsonic transport aircraft system improvements, dynamic seals for aerospace, seal and flange design, fluid power support systems, fluid power system techniques, contamination problems, clean rooms and contamination control of fluid power, fluid amplifiers, reliability and maintainability in hydraulics, gas fluid power systems, pneumatic systems, new techniques in circuitry, new fluid power techniques, and new servovalue concepts. (R.C.K.)

14372 DEVICE FOR DETECTING SMALL CHANGES IN THE ISOTOPIC PURITY OF WATER. Bayly, J. G. (to Atomic Energy of Canada Ltd.). Canadian Patent 750,537. Jan. 10, 1967.

The infrared transmission properties of a water sample are directly compared with the same properties of a reference water sample. At certain wave lengths in the infrared spectrum

significant differences occur in the manner of transmission through light water compared with that through heavy water. The D/H ratio may then be determined. A flow modulator incorporating bellows alternately flushes water to be analyzed and reference sample water several times a second through a suitable cell placed in the path of an infrared beam, whose wavelength is chosen for maximum sensitivity. A detector compares and amplifies the two signals received. To compensate for interfering contaminants, a second wave length is then used but having a known quantity of contaminant in the reference sample. The infrared transmissions in a sample and in a reference stream are compared at two wavelengths to give an analysis which is insensitive to contaminants commonly found in water yet responds to 0.5 ppM D_2O near the natural abundance (150 ppM) and can have a range to at least 5000 ppM. A minimum of thirty streams can be analyzed per hour. (F.S.A.)

14373 MTR FUEL ASSEMBLIES, MECHANICALLY ASSEMBLED (Engineering Materials). (Idaho Nuclear Corp., Idaho Falls). (CAPE–1534).

29 drawings.

Mechanically assembled fuel elements for the Materials Testing Reactor are described. The element consists of 19 plates containing 200 g of ^{235}U alloyed with Al. The elements must be strong and rigid and able to withstand hydraulic forces from water flowing at 33 ft/sec. (For details see TID-4100 Suppl. 39) (F.S.)

14374 REGENERATIVE EMF BIMETALLIC CELL (Engineering Materials). (Argonne National Lab., Ill.). (CAPE–1522).

3 drawings.

A sodium–bismuth regenerable emf electrolytic cell in which the fused salts and metals are at about 500 to 600°C is described. The device may be heated and cooled without damaging the vacuum seal employed. The vacuum seal eliminates expansion problems with dissimilar materials uses the vacuum to hold the 2 cell halves together while an Al and a silicon rubber gasket, each held between 2 flanges extending out from the edges of the cells, hold the 2 halves of the cell apart. The rubber gasket preserves the vacuum seal and the Al gasket serves as the liquid seal and electrically separates the 2 cell halves. (For details see TID-4100 Suppl. 39) (F.S.)

14375 NIM SYSTEM ±12V, ±24V POWER SUPPLY, 50ma [Q-3004] (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1536).

9 drawings.

The power supply is packaged in a single width NIM standard module for use in a NIM standard bin. It is used on bins that do not have the NIM Type III Power Supply attached (Q-2832 see CAPE-1463). The module will supply ±12V or ±24V at a maximum current of 50 mA. Each output is independently current-limited at ~55 mA. The temperature coefficient is 0.001%/°C for an ambient temperature of 0°C to 50°C. Less than 1 mV peak-to-peak noise and ripple were observed on a 50 mc bandwidth oscilloscope. (For details see TID-4100 Suppl. 39) (F.S.)

14376 USE OF AN ELECTRONIC DIGITAL COMPUTER IN A METROLOGY LABORATORY. Becker, A.; Grinberg, B.; Le Gallic, Y. (CEN de Saclay, Gif-sur-Yvette, France). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/32, 11p. (In French). (CONF-661012–32). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

Methods developed in recent years for radioanalysis and determination of the activity of radioelements involve calculations beyond the capabilities of office machines. Data of the type supplied by modern research instruments can only be processed with the aid of an electronic digital computer. The machines used are the universal type consisting of a central 10K unit, together with the ancillary equipment indispensable to a punched tape system, and a magnetic tape unit with transfer coordinator and marking-out table. The equipment is programmed using a language related to FORTRAN IV. Programs have been developed in the light of various important requirements in metrology. Programs have been written for the determination of counter threshold slope and determination of source activity using the Chauvenet criterion; the determination of activity using the $4\pi\ \beta-\gamma$ coincidence method; determination of half life; use of a least squares method to calibrate measuring instruments both of the numerating and of the integrating type; and calibration of neutron sources using the integrated relative activities of a manganese solution flowing under constant irradiation. (tr-auth)

Heat Transfer and Fluid Flow

Refer also to abstract 14401.

14377 (ALO–3633-3) DEVELOP 1800F–400F FIBROUS-TYPE INSULATION FOR RADIOISOTOPE POWER SYSTEMS. Third Quarterly Progress Report, October 3 to December 30, 1966. Collins, J. O. (Johns-Manville Research and Engineering Center, Manville, N. J.). Jan. 3, 1967. Contract AT(30-1)-3633. 61p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The physical properties (excluding thermal conductivity) of MICROTHERM were investigated. Formulations 1999 and 2002, developed for lead telluride service, have been placed under prolonged compatibility tests, as have the fibrous candidates for the higher temperature silicon–germanium service. A complete evaluation of the stress-strain characteristic of Formulation 2002 and the effect of numerous variables on this characteristic has been completed. Developmental efforts are concentrated upon a more thermally stable formulation for application in silicon–germanium systems. (auth)

14378 (EURAEC–1092) SOME SPACER EFFECTS IN ANNULAR AND CLUSTER GEOMETRIES IN TWO-PHASE ANNULAR-DISPERSED FLOW. Topical Report No. 17. Alia, P.; Cravarolo, L.; Hassid, A.; Pedrocchi, E. (Centro Informazioni Studi Esperienze, Milan (Italy)). Nov. 1966. Contract 060-61-7-RDI. 58p. (CISE-R–110; EUR–3341). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The results of experiments in a preliminary investigation into the effect of spacers in annuli and cluster geometries in the vertical upward flow of two-phase (gas + liquid) mixtures in adiabatic conditions are discussed. Investigated were the pressure losses across a spacer in a bundle of rods and film thickness variation across a spacer in an annulus. The experiments were carried out under the following conditions: vertical upward flow (in annular-dispersed regime); gas phase argon and liquid phase water were used; gas flow rate of 8 to 120 g/cm^2 sec; liquid flow rate of 18 to 200 g/cm^2 sec; temperature near 18°C; and pressure up to 22 kg/cm^2. (auth)

14379 (EURAEC–1544) SWIRL FLOWS IN BOILING WATER. CRITICAL FLUX IN SWIRL FLOW IN A TUBE. Special Report No. 21. Rosuel, A.; Sourioux, G.; Dolle, J.; Sandrin, J. (Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Suresnes (France). Division Atomique). Oct. 18, 1965. Contract 0-61-64-7-TEE-F(RD). 45p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The influence of the heating length of the channel, mass velocity, and fluid enthalpy at the heating channel inlet were examined in defining the critical flux in swirl flow. Tubular geometry was used to facilitate calculation of local quality at right angles to burnout. Tests showed that centrifugation of a two-phase water-steam mixture had a considerable effect on the thermal performance of a heating channel. It was impossible to obtain any considerable subsaturation, but with 4% sub-saturation, it was possible to reach 100% exit quality. The influence of mass velocity tends to increase the fluxes. The effect of centrifugation on critical flux was not fully clarified but it does increase the flux. It is impossible to extrapolate the results to different geometries, in particular to rod clusters. (F.S.)

14380 (EURAEC–1550) STUDY ON BURNOUT HEAT FLUX IN BOILING WATER. Quarterly Report No. 17, October 1–December 31, 1965. Mayinger, F.; Schad, O.; Weiss, E. (Maschinenfabrik Augsburg-Nuernberg A. G., Nuremberg (West Germany)). Jan. 1966. Contract 057-61-RDD. 42p. (EUR–2692). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Under certain hydrodynamic, thermodynamic and structural conditions pulsations can be set up in heated channels which cause burnout at a much lower critical heat flux than is the case with normal film boiling under stable flow conditions. Compressible media increase the tendency toward pulsations upstream of the heated channel, while orifices reduce them. Studies were performed to determine the minimum orificing necessary at the inlet of the heated channel to prevent these pulsations. (auth)

14381 (EURAEC–1611) STUDY OF THE FLOW DISTRIBUTION IN A TWO-CHANNEL TEST SECTION. Special Report No. 24. (Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Suresnes (France). Division Atomique). Feb. 10, 1966. Contract 061-64-7-TEEF(D). 40p. (EUR–2824). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The phenomenon of flow distribution between two parallel chan-

nels, in vortex flow is described. Whatever the flow conditions, there is a transfer of mass between the two channels. The intensity of this transfer depends on the flow velocity conditions. At a given flow velocity, the homogenization length decreases if the flow of gas in the channels increases (this amounts to increasing the true velocities of the fluids). With a very low air flow, the nature of the flow gives very great homogenization lengths. Forces induced by vortex flow, which tend to group the light phase at the center of the channel are considered. With a high air flow, mixing is very violent. The preparation of a model necessitates a finer analysis of the problem. In particular, it is necessary to know the local conditions at the interface of the channels. (auth)

14382 (GEAP–4769) TRANSITION BOILING HEAT TRANSFER PROGRAM. Eighth Quarterly Progress Report, October–December 1964. Quinn, E. P. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jan. 1, 1965. Contract AT(04-3)-189. 28p. (EURAEC–1300). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Progress is reported on investigations of transition boiling heat transfer for application to nuclear reactors. Single-rod tests for the development of finned heated surfaces capable of reducing transition boiling temperature fluctuations and improving film boiling coefficients have been concluded. Tests with a 0.004 in. high finned heated rod indicate a 5 to 1 reduction in temperature fluctuations. Fins with this height will be used in future three-rod assembly tests. Pressure drop measurements taken during cold-water flow tests indicate that oscillations detected during the two-phase heat transfer tests are not entirely due to loop hydraulic disturbances. Additional tests are necessary to improve film exposure. (L.C.L.)

14383 (GEAP–4783) RADIAL VANE STEAM SEPARATOR DEVELOPMENT. Second Quarterly Report, October–December 1964. Moen, R. H. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jan. 1965. Contract AT(04-3)-189. 42p. (EURAEC–1301). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Further tests of the model radial vane separator were carried out to determine the effect of plenum deflectors on performance, the separator performance with six 18-inch nozzles and eighteen 6-inch nozzles, the spread of water flow on the vanes, and the effect of carryover sample flow rate on carryover readings. The data obtained were partially analyzed and the following conclusions made: plenum deflectors are unnecessary at the test conditions; carryover is a function of nozzle velocity rather than vertical steam velocity as long as the surface of the lower vortex does not contact the vane bottoms. This indicates that nozzle-and-vane geometry may be altered to give better performance; the water flow from the nozzles on the vanes does not spread while flowing from the nozzles to the vane ends; and the carryover at the level of the vane tops, the carryunder, and the pressure drop determined in the June tests are valid and confirm the results of the October tests. The two-vane adjustable nozzle unit construction is proceeding, the two-vane clear plastic unit has been designed, rough calculations of the sizes of the new separators for air-water tests have been calculated, a generalized solution of the equation for the thickness of the upper vortex has been calculated, and a preliminary layout of the modification of the Large Air-Water Test Facility has been made. (auth)

14384 (KR–110) SLIP RATIOS AND FRICTION FACTORS IN THE BUBBLE FLOW REGIME IN VERTICAL TUBES. Malnes, Dag (Institutt for Atomenergi, Kjeller (Norway)). May 1966. 174p. Dep. mn.

Thesis.

Slip ratios in the vertical bubble flow regime have been measured in adiabatic air-water and steam-water flow. The experimental data confirm that the slip ratio in bubble flow may be represented by two terms. The first term is due to the relative velocity between bubbles and water and may be represented by the ratio of rise velocity of single bubbles in still liquids to liquid velocity. The second term is caused by the relative distribution of gas and liquid and may be represented by a Bankoff type expression. The second term is dependent on the initial conditions, as a fully developed two-phase flow is largely delayed compared to one phase flow. Slip ratios in bubble flow are independent of tube diameter for the present data with tube diameters above 25 mm. Void fraction distributions have been measured by means of void needles with standard deviations below 2% void in air-water. Bubble velocity distributions in steam-water have been measured by means of void needles and a cross correlation technique. Two-phase friction in air-water has been measured directly by means of a friction tube. Combined with a pressure drop measurement, the friction tube has been used as a void fraction measuring device as well. (auth)

14385 HEAT-TRANSFER AND FRICTION PROPERTIES OF SURFACES WITH DISCRETE ROUGHNESSES. Sheriff, N.; Gumley, P. (United Kingdom Atomic Energy Authority, Risley, Eng.). Int. J. Heat Mass Transfer, 9: 1297-1320(Dec. 1966).

The heat transfer and friction characteristics of a surface with discrete roughnesses have been investigated experimentally. The surfaces were roughened by means of a wire wrapping at a constant pitch-to-wire diameter ratio of 10:1, with wire sizes varying from 0.002- to 0.040-in dia. A simple correlation on the basis of a non-dimensional roughness parameter e^+ was found to be useful, but a more exact correlation, on the basis of a two-layer model of the heat transfer resistance was more exact. In this model the heat transfer process was subdivided into a region from the wall to the envelope enclosing the roughness tips, and a central core region. The heat transfer resistance from the wall to the roughness tips has a minimum value at $e^+ \sim 35$, and this produces an optimum heat transfer surface. (auth)

Isotope Technology

Refer also to abstracts 14340 and 14377.

14386 (AAEC-TM–309) SELECTION OF RADIATION SOURCES IN RADIOGRAPHY. Chrimes, N. W. D.; Wright, W. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Dec. 1965. 27p. Dep. mn.

The characteristics required of a radiation source for radiography are: the wavelength of the beam must be suitable, considering the thickness and absorption coefficient of the material under examination, to obtain adequate contrast in the radiograph; the beam must have a high intensity to reduce the exposure time; and the source should be of small diameter to reduce geometric unsharpness of the image. These optimum conditions are readily obtained with x-ray generators. With isotopes, the beam intensity is usually lower than that attainable with x-ray generators and the wavelengths of the beam are decided by the initial choice of isotope. Consequently the exposure times required for isotopes are relatively long compared with those used in x-radiography. The comparative absence of gamma emitters with energies in the range 0.1 to 0.4 MeV means that sensitivities will be relatively poor for the range of materials and thicknesses most frequently encountered. The advantages of isotope sources are the low capital investment required and their convenience in use under conditions where no electricity and water are available or where it is impossible to locate an x-ray source. The characteristics of a number of isotope sources are discussed in relation to their potential for radiography. (auth)

14387 (CONF-660221–, pp 316-20) CONSTRUCTION OF AN ELECTROMAGNETIC ISOTOPE SEPARATOR. Damodaran, K. K.; Gowariker, S. R. (Atomic Energy Establishment, Trombay (India)).

The construction of an electromagnetic separator is described. The separator is capable of separating isotopes of light, medium, and heavy mass numbers in milligram quantities. Three types of ion sources may be used for solid charges, for gaseous charges, and for charge materials with extremely high melting points. A schematic diagram of the isotope separator is given. (R.C.K.)

14388 (DP–1094) SAVANNAH RIVER LABORATORY ISOTOPIC POWER AND HEAT SOURCES. Quarterly Progress Report, October–December 1966. Hilborn, H. S. (comp.) (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Jan. 1967. Contract AT(07-2)-1. 29p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A program to develop, fabricate, and test capsules containing (1) ^{60}Co in an oxidation resistant cladding and (2) a higher temperature form of ^{60}Co in a refractory metal cladding was undertaken to meet the needs of heat source designers and users. Of the capsule materials tested, "Inconel" 600 and TD Nickel are most compatible with cobalt metal. TD Nickel Chromium had outstanding oxidation resistance. Cobalt-60 heat sources were shown to require lighter shields than $^{90}SrTiO_3$ heat sources at powers above 2 kW(t). A second program dealing with the development of technology needed for large-scale manufacture of ^{244}Cm fuel capsules is described. The monoclinic B-type Cm_2O_3 appeared to be the best curium oxide for heat sources. A cermet compact of Cm_2O_3 with tungsten, fabricated by cold pressing and sintering at 1850°C, showed no deleterious interaction between the oxide and metal particles. A shipping container for transporting curium oxide in 120 g batches was designed. (L.C.L.)

14389 (EUR–2776.d) DIE ANWENDUNG GESCHLOSSENER RADIOISOTOPE IN DER INDUSTRIE (FALLSTUDIEN 5 bis 8).

(The Use of Sealed Radioisotopes in Industry (Key Studies 5 to 8). Wieczorek, H.; Erhardt, H. (Laboratorium Prof. Dr. Berthold, Wildbad im Schwarzwald (West Germany)). 1966. 30p. (In German). Dep. mn.

Studies were made to examine typical instances of the use of sealed radioactive isotopes in industrial measuring methods. All technical, economic and labor-research aspects involved in the use of isotopes are discussed. The measurement of the charge height in a cupola furnace and the application of nuclear level gauging devices in automatic charging are described. The use of the isotope-regulated charging hoist has the effect of increasing a cupola furnace's productivity in terms of man-power and making the smelting operation a smoother process. By saving labor, the costs of the isotope hoist is recovered in about 3 months' time. Studies were also conducted on the use of isotopes to measure the filling height in pressure tanks in which chemical syntheses are carried out. In the case investigated, the nuclear method was the only possible way of measuring the level in the pressure vessel and thus, in addition to the level gaging, made it possible to distinguish the various phases of the medium and the occurrence of foam. The use of radioactive isotopes in measuring filling level and density in the production of aluminum oxide from bauxite according to the Bayer process was investigated. Owing to the heavy incrustations that occur in the tanks, the conventional instruments cannot be employed. In this process the continuity of the whole system depends essentially on the use of such nuclear equipment. Its introduction offers the best solution of level gaging and density measurement as well as the control problems present in this process. (tr-auth)

14390 (MMM-3691-12) SNAP-21 PROGRAM, PHASE II. DEEP SEA RADIOISOTOPE-FUELED THERMOELECTRIC GENERATOR POWER SUPPLY SYSTEM. Quarterly Report No. 2, October 1–December 31, 1966. Weinig, J. F. X. (Minnesota Mining and Mfg. Co., St. Paul. Isotope Power Lab.). Feb. 1967. Contract AT(30-1)-3691. 156p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A study of the dynamic loads that a SNAP-21 system will experience during its operational life was conducted. A structural design analysis was made and verified by dynamic testing. These tests included conditions which could occur during assembly and handling, transportation, implantment, and recovery of the system. The effects of the dynamic loads were determined, and design modifications specified. Plans for the nondestructive (ultrasonic) testing of the SNAP-21 fuel capsule are outlined. Progress in component design and development is reported. Cold end heat transfer tests for the thermoelectric generator were begun. Thermopile drawings for these generators were released. The insulation system received special attention such as: offgassing tests, weld development, getter retainer analysis and testing, and seal-off device design work. (L.C.L.)

14391 (ORNL-TM-1505(Pt.4)) SELECTED ABSTRACTS OF NON-U. S. LITERATURE ON PRODUCTION AND INDUSTRIAL USES OF RADIOISOTOPES (FROM NSA OCTOBER TO DECEMBER 1966). Gerrard, Martha; Baker, P. S.; Lafferty, Robert H. Jr. (Oak Ridge National Lab., Tenn.). Feb. 1967. Contract W-7405-eng-26. 45p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

About 350 abstracts of non-U. S. publications on production and use of radioisotopes and radiation, selected from the Oct. to Dec. 1966 issues of Nuclear Science Abstracts, are presented. (auth)

14392 (STL-517-0049(Vol.2B)) RADIOISOTOPE PROPULSION TECHNOLOGY PROGRAM (POODLE). VOLUME IIB. ANALYTICAL PROGRAM FOR CREEP IN AXISYMMETRIC BODIES (CRAB). Final Report, October 1, 1965–September 30, 1966. Greenbaum, G. A. (TRW Systems, Redondo Beach, Calif.). Oct. 1966. Contract AT(04-3)-517. 57p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An analysis and a numerical computer program were developed for the calculation of creep strains in an arbitrary axisymmetric body of revolution subject to axisymmetric loads. The method of solution is an extension of the direct stiffness method. The body is replaced by a system of discrete triangular cross section ring elements interconnected along circumferential nodal circles. The equations of equilibrium for the body are derived from the principle of minimum potential energy. The creep behavior of the body is obtained by the use of an incremental approach. The method involves starting with the elastic solution of the problem and calculating the creep strains for a small time increment. These creep strains are treated as initial strains to determine the new stress distribution at the end of the time increment. The procedure is repeated until either the final time or, a steady-state condition is reached. The method is quite general and is independent of the type of creep law used. Results are presented for a plane-strain cylinder solution and a pressure vessel with spherical end caps. (auth)

14393 APPLICATION OF ACTIVATION ANALYSIS ON STREAM FLOW MEASUREMENT. Kobayashi, Masatoshi (Japan Atomic Energy Research Inst., Tokyo); Horiguchi, Yasuhiro. Radioisotopes (Tokyo), 15: 317-24(Nov. 1966).

Tracer experiments to measure the velocity, flow rate and the dilution rate were carried out on the River Kandagawa and the River Nipparagawa. Small quantities of ^{24}Na or ^{82}Br solutions were injected into the rivers as a "pulse" together with rather large quantities of a nonradioactive solution, prior to the continuous injection of a nonradioactive tracer solution. The aim of such a double tracer technique was to compare the advantages and the disadvantages of the radioactive tracer method and the nonradioactive tracer method, and to examine the sorption loss of the tracer by using different elements at the same time. The counting efficiencies of various methods were examined as well as the effectiveness of the total counting method. (NSA of Japan)

14394 USE OF ISOTOPES IN INDUSTRY. Bizzell, Oscar M. (Atomic Energy Commission, Washington, D. C.). pp 161-8 of Institute of Nuclear Materials Management Sixth Annual Meeting, Columbus, Ohio, Institute of Nuclear Materials Management, 1965.

The industrial utilization of radioisotopes as sources of radiation and for tracer applications are discussed. The following industrial uses are presented: changing the properties of materials, such as plastics and wood; production of new materials, such as biodegradable detergents; production of materials previously made by other methods, such as ethyl bromide; food processing; radioisotope batteries; heating, tracing, and measuring such properties as density, thickness, and porosity. It is estimated that the business has an annual growth rate of about 5%. With a little improvement in licensing, pricing and public relations a growth potential of 20% per yr is possible. Recommendations are presented to achieve this growth potential. (F.S.)

14395 USE OF A WEIGHTLESS SOURCE TO DETERMINE SELF-ABSORPTION IN THIN BETA SOURCES. Denisikov, A. I.; Dorofeev, G. A.; Sobolev, Yu. P. Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/73, 8p. (In Russian). (CONF-661012-33). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

A method of determining self-absorption in a thin beta source by comparing its activity with that of a "weightless" source is described. The technique presented is for determining self-absorption for ^{60}Co sources. (auth)

14396 ISOTOPE BRAYTON CYCLE POWERPLANTS FOR ORBITING SPACE STATIONS. Clausi, J. V.; Schmitt, J. W. (Pratt and Whitney Aircraft, East Hartford, Conn.). 18p. (CONF-660708-9). DTIE. Gmelin, AED-CONF-66-232-4.

From Institute of Electrical and Electronics Engineers, Summer Meeting, New Orleans.

An isotope Brayton cycle powerplant is described. Powerplant reliability to meet mission requirements can be obtained by a combination of redundant components and maintenance capability in space. The selection of the type of turbomachinery affects the power-conditioning requirements. Either single shaft or two-shaft machinery can be integrated with a spacecraft power system. The detailed differences between these two approaches can only be evaluated on the basis of a complete mechanical and system design which includes integration with the remaining spacecraft systems. A close interaction exists between the power system performance and the requirements placed on the power system by the mission requirements as indicated in the radiator area limit-operating temperature trade-offs. (auth)

Materials Testing

Refer also to abstracts 14377 and 14390.

14397 (BNWL-364) UNIQUE DETERMINATION OF EDDY CURRENT FLOW PATTERNS FROM MEASUREMENTS OF EXTERNAL FIELDS. Churchill, M. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 1967. Contract AT(45-1)-1830. 9p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A method is described for predicting current patterns in a sample by impressing an electromagnetic field on the sample and measuring the resulting fields at the surface. (B.G.D.)

14398 (ORNL-P-2811) INSPECTION OF SMALL SPECIALTY WELDS AND BRAZED JOINTS FOR NUCLEAR SERVICE. McClung, R. W. (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26. 24p. (CONF-670102-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 2nd Annual Symposium on Nondestructive Testing of Welds, Chicago, Ill.

Radiography as a prime tool for the detection of discontinuities in small complex welds is discussed. Masking techniques improve the image quality and can reduce the number of necessary exposures. Liquid-penetrant examination and helium-leak testing are also regularly used for closure-weld examination. Ultrasonic techniques are useful for the detection of nonbonding in brazed joints. The techniques include the use of resonance, "ringing," Lamb waves, and reflection. The choice of specific technique depends on a number of factors such as the thickness of cladding and substrate, the required bond quality, and the accessibility of the joint to be inspected. (auth)

14399 (WAPD-Trans-46) WELDING PROCESS WITH X-RAY CONTROL OF WELD QUALITY. Stehle, Heinz; Kaden, Werner; Schaal, Alfred. Translated for Bettis Atomic Power Lab., West Mifflin, Pa., from German Patent PLA-66/1342. 5p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.10 fs, $0.80 mf.

A welding process is described whereby x-ray control of weld quality is carried out, preferably by a conventional reflection method, simultaneously with the production of the welded seam on a turning workpiece. This method is particularly useful for circular seams in the end caps of nuclear reactor fuel rod jackets. (P.C.H.)

14400 DETERMINATION OF DENSITY OF LARGE-AREA CONCRETE CONSTRUCTION ELEMENTS BY USING THE GAMMA-RAY TRANSMISSION TECHNIQUE. Pohl, E. (Hochschule fuer Bauwesen, Leipzig). Isotopenpraxis, 2: 454-8 (Dec. 1966). (In German).

Density is an important factor for construction elements of concrete utilized as the elements of outer walls because of its decisive influence on the thermal insulating properties. At present, no nondestructive method of materials testing is known which permits control of homogeneity and density of large-area construction elements. Using the gamma-ray transmission technique makes it possible to determine the density with a relative accuracy better than ±3%. The errors of measuring due to changes in geometry are given and some measuring devices proved accurate in practice are described. (tr-auth)

14401 MATERIAL AND GEOMETRY ASPECTS OF SPACE RADIATORS. Lieblein, Seymour; Diedrich, James H. (Lewis Research Center, Cleveland). Nucl. Appl., 3: 82-93(Feb. 1967).

Materials and fin-tube geometry have a large influence on the ultimate size and mass of a waste-heat radiator for use in space. In turn, many factors, such as meteoroid damage protection, structural integrity, vehicle integration, and fluid compatibility, influence the requirements for materials and geometry. A wide variety of materials and geometries can be considered. (auth)

14402 STUDIES ON THE CONTAINER FOR DISPOSING RADIOACTIVE WASTES INTO THE SEA. 1. LOAD EXPERIMENTS OF MORTAR CYLINDERS AT A CONSTANT HYDRAULIC PRESSURE. Sasaki, Tadayoshi (Tokyo Univ. Inst. of Physical and Chemical Research, Tokyo); Watanabe, Seiichi. Nippon Kaiyo Gakkaishi, 22: 138-44(Aug. 1966). (In Japanese).

Cylindrical concrete containers were tested at a hydraulic pressure increased stepwise from one-half of the collapse pressure, which was estimated from the previous experiment, to the pressure at which a cylinder collapsed due to creep. A strain on a concrete wall was also measured using a strain gage and an empirical formula, which indicated the progress of creep. From the formula and the strain at collapse, the safety period of a container was estimated. (NSA of Japan)

Protective Structures

14403 (AD-635502) SHELTER OCCUPANCY STUDIES AT THE UNIVERSITY OF GEORGIA (APPENDICES). (Georgia Univ., Athens). Dec. 31, 1965. Contract OCD-PS-65-45. 198p. CFSTI $5.00 cy, $1.00 mn.

See also AD-635501.

Participants in a fallout shelter study at the University of Georgia from 1962 through 1965 were men, women, and children aged 1-70 years. Data from pre-shelter questionnaires, medical records, diaries, and shelteree personal possessions data are presented. Also tabulated are environmental and operating program data. (F.S.)

14404 (PSDC-TR-16) EXPERIMENTAL EVALUATION OF ROOF REDUCTION FACTORS. McDonnell, C.; Velletri, J. (Conesco, Cambridge, Mass.). May 1, 1966. Contract DA-18-020-ENG-3407. 73p.

For Protective Structures Development Center, Fort Belvoir, Va.

A major portion of the radiation dose received within a structure is due to the fallout deposited on the roof. Experiments were conducted to measure the attenuation introduced by the roof to this radiation as a function of the mass thickness and the solid angle fraction subtended by the roof source to a detector in the structure. The first series of experiments conducted on a roof of an inhomogeneous mass distribution, determined the attenuation introduced by mass thicknesses of 0, 48.6, 97.2 and 145.8 psf. Qualitative agreement between data from these experiments and calculated values made in an infinite homogeneous media is good. Measured dose rates from a rectangular source array of eccentricity 1.5 agreed within 10% with a circular source array subtending the same solid angle fractions. A second series of experiments designed to closely simulate the analytical model used in the theoretical calculations was conducted for mass thicknesses of 0, 48.6, 97.2 and 145.8 psf. A maximum discrepancy of 15% is shown between theory and experiment for all mass thicknesses investigated. (auth)

Radioactive Material Handling

Refer also to abstracts 14331 and 14402.

14405 (LA-DC-8395) APPLICATION OF INDUSTRIAL SAFETY PRACTICES TO NUCLEAR SAFETY. Reider, Roy (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 15p. (CONF-661206-4). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From American Nuclear Society National Topical Meeting, Nuclear Criticality Safety, Las Vegas, Nev.

Application of industrial safety practices in handling stored coal and low or deflagrating explosives are compared to the problems involved in handling critical masses safely in nuclear energy. The problems of safety motivation are also discussed. The motivation for safety may be either directed or self-induced. (F.S.)

14406 (WASH-2808) STUDY ON INTERNATIONAL TRAFFIC OF RADIOACTIVE MATERIALS. Final Report. (Southern Interstate Nuclear Board, Atlanta, Ga.). July 17, 1966. Contract AT(49-14)-2808. 271p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A comprehensive study is reported on the transportation of radioactive and fissile materials as an aid in developing improved practical and economic conditions of radioactive and fissile material movement to and from the United States. The following factors which affect this movement were studied: land, water, and air transportation; insurance and indemnity aspects; legal factors; casks and containers; health and safety; physical and human capabilities; and present and future markets. Major obstacles were found to be the reluctance of certain carriers to transport fissile materials in conventional commerce; lack of satisfactory nuclear indemnification for movement on the high seas or by means of air transport. (F.S.)

14407 THE TREATMENT OF LIQUID AND SOLID RADIOACTIVE WASTES AT CISE. Cerrai, E.; Triulzi, C. (CISE, Milan). Energ. Nucl. (Milan), 13: 554-63(Oct. 1966). (In Italian).

Methods are described for the handling, treatment, and disposal of liquid and solid radioactive wastes at CISE Laboratories in Italy. For safety reasons the criterion adopted for the discharge liquids outside the Center is that the waste activity concentration in the discharge canal must be kept lower than 10^{-7} μCi/cm^3, that is a limit valid for drinkable water in the case of any mixture of beta and gamma emitters. The operating characteristics of the liquid decontamination plant are given. Solid wastes are stored in specially equipped containers. Quantities of wastes treated or stored according to their different categories in the period 1961 to 1966 are given. (tr-auth)

14408 REMOVAL OF RADIOACTIVE NOBLE GASES FROM OFF-GAS STREAMS. Keilholtz, G. W. Nucl. Safety, 8: 155-60 (Winter 1966-1967).

Radioactive noble gases, particularly fission-product krypton and xenon, must either be removed from the off-gas streams of reactors and nuclear fuel-processing plants or diluted to low concentrations before the off-gases are released to the atmosphere. For practical purposes they can be removed only from small volumes or from low-velocity gas streams and only by physical processes. Some current technological developments are reviewed. (auth)

14409 REPORT ON THE 1966 SYMPOSIUM ON SOLIDIFICATION AND LONG-TERM STORAGE OF HIGHLY RADIOACTIVE WASTES. Belter, Walter G. (Div. of Reactor Development and Technology, AEC, Washington, D. C.). Nucl. Safety, 8: 165-74(Winter 1966-1967).

Forty-seven papers were presented and one panel discussion was held during the symposium on Solidification and Long-Term Storage of Highly Radioactive Wastes held February 14 to 18,

1966, at Richland, Wash. The symposium was notable in that it marked the first time U. S. industry had attended a meeting on management of high-level waste. The long-range plans and requirements for management of high-activity waste in the United Kingdom, France, Germany, Belgium (Eurochemic), and the United States, as well as the technical status of research and development on waste solidification and long-term storage are reviewed. (auth)

14410 BEHAVIOR OF RADIOACTIVE GASES DISCHARGED INTO THE GROUND. Jacobs, D. G. Nucl. Safety, 8: 175-8 (Winter 1966-1967).

The feasibility of discharging radioactive gases and aerosols from a reactor containment vessel into the ground following a fuel-meltdown incident has been discussed by an AEC working group. This review incorporates much of the information discussed. The behavior of various radionuclides in the ground depends on the physical properties affecting the movement of fluids in the ground as modified by reactions between the radionuclides and the geologic formation. When injection is completed the subsequent movement of the radionuclides results from natural convective transport of the formation fluids and from molecular diffusion. The extent of movement of most of the gaseous radionuclides is limited by their radioactive decay. (auth)

14411 INSTITUTE OF NUCLEAR MATERIALS MANAGEMENT SIXTH ANNUAL MEETING, CINCINNATI, OHIO, MAY 10, 11, AND 12, 1965. Columbus, Ohio, Institute of Nuclear Materials Management, 1965. 193p. $5.00. (CONF-650532).

Fourteen papers are included from the 6th Annual Meeting of the Institute of Nuclear Materials Management. Separate abstracts have been prepared for 12 papers. The remaining two papers have been previously abstracted in NSA. For abstracts of these papers see abstracts 19:38185 and 20:1533. (F.S.)

14412 BRIEF REVIEW OF THE INTERNATIONAL SYMPOSIUM HELD IN ALBUQUERQUE, NEW MEXICO. Delnay, R. L. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. pp 51-6 of Institute of Nuclear Materials Management Sixth Annual Meeting. Columbus, Ohio, Institute of Nuclear Materials Management, 1965.

A brief review of the Symposium on Packaging and Transportation of Radioactive Materials held in Albuquerque, New Mexico, in January 1965 is given. The following topics were reported: regulations governing the packaging and transportation of radioactive materials; structural integrity tests of packages used prior to regulations 10 CFR 71 and 0529; packages designed to meet these regulations; and observations of a fire and drop test. (F.S.)

14413 STATUS OF REGULATORY PROGRAM. Barker, Robert F. (Atomic Energy Commission, Washington, D. C.). pp 73-90 of Institute of Nuclear Materials Management Sixth Annual Meeting. Columbus, Ohio, Institute of Nuclear Materials Management, 1965.

Recent developments and the present status of regulations, with emphasis on the transportation of nuclear or fissile materials, are discussed. Five federal agencies have regulations governing the packaging and transportation of fissile materials. The Interstate Commerce Commission's (ICC) regulations provide basic limits on packaging. The Federal Aviation Agency, Post Office Department, and the U. S. Coast Guard follow closely the ICC regulations. The AEC's regulations are closely related to those of the other agencies. The revision of the nuclear safety performance standards being considered by the AEC is discussed. The development of universally acceptable regulations for international transport of radioactive materials by the International Atomic Energy Agency is also discussed. (F.S.)

14414 VOLUMETRIC CALIBRATION OF PROCESS VESSELS USING DIGITAL COMPUTER TECHNIQUES. Doher, Louis W.; Schulz, Jack A. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. pp 91-120 of Institute of Nuclear Materials Management Sixth Annual Meeting. Columbus, Ohio, Institute of Nuclear Materials Management, 1965.

A procedure for accurately and speedily calibrating tanks used for the chemical processing of nuclear materials is described. The procedure features the use of precalibrated vessels certified to deliver known volumes of liquid, calibrated linear measuring devices, and a digital computer for manipulating data and producing printed calibration information. Calibration records of the standards are traceable to primary standards. Logic is incorporated in the computer program to accomplish curve fitting and perform the tests to accept or to reject the calibration, based on statistical, empirical, and report requirements. This logic is believed to be unique. (auth)

14415 WHAT PRICE LOSS OF CONTROL. Thomas, C. C. (Western New York Nuclear Research Center, Buffalo). pp 157-60 of Institute of Nuclear Materials Management Sixth Annual Meeting. Columbus, Ohio, Institute of Nuclear Materials Management, 1965.

Problems involved in the control of special nuclear materials are discussed. One of the principles of nuclear materials management is that the materials should receive attention compatible with its dollar value. An incident is discussed in which loss of control was about three orders of magnitude more costly than the effort which would have been required for appropriate control of the material. (R.C.K.)

Vacuum Engineering

14416 (CONF-660221-, pp 330-3) EFFICIENCY OF A GETTER-ION PUMP. Nambiar, K. B.; Divatia, A. S. (Atomic Energy Establishment, Trombay (India)).

In order to determine the efficiency of a getter ion pump a study of the outgassing of the system and the performance of the getter material in the pump is presented. The distribution of the getter material on the chamber walls was also studied. (B.G.D.)

14417 BAKEABLE INFRARED WINDOW FOR ULTRAHIGH VACUUM SERVICE. Eisenstadt, Melvin M. (Univ. of California, Santa Barbara). Rev. Sci. Instrum., 38: 134-5(Jan. 1967).

A bakeable infrared window for ultrahigh vacuum service is described. The window assembly consists of a sterling silver flange with a 1 mm thick layer of AgCl as a seal placed against a T-12 infrared window. The assembly was heated to 500°C to melt the seal, then slowly cooled. The apparatus was heated to 250°C at a rate of 1°/min and cooled to room temperature at 5°/min, and no leaks were found. Results are also given for experiments with unsuccessful sealing combinations tested prior to the silver flange—AgCl method. (L.C.L.)

14418 VACUUM GAGE (Engineering Materials). (Univ. of California, Livermore). (CAPE-1541).

24 drawings.

The vacuum gage is useful over a pressure range of 10^{-3} to 2×10^{-10} torr and will operate with cable runs up to 15 ft. The unit is constructed of standard plates with a panel height of 5¼ in. and weighs ~17 lb. Maximum power consumption is 100 W and the rated input voltage is 105 to 125 V, 50 to 60 cycles. The unit was designed to be used with Veeco TG-7, RG 75, or CEM 75 tubes. Other tubes requiring 10 mA emission current and 150 V at the grid may be used provided the filament current requirements are the same. (F.S.)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 14654, 14978, 15542, 15545, 15588, and 15597.

14419 (AECL–2604) DETECTION OF TRITIUM IN AIR WITH IONIZATION CHAMBERS. Osborne, R. V.; Cowper, G. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Oct. 1966. 24p. Dep. mn. AECL $1.00.

Monitors for detecting tritium in air in the presence of gamma radiation have been made by mounting, coaxially, a sealed ionization chamber inside an ionization chamber which can sample the surrounding air. The effective volume of the outer chamber is equal to that of the sealed chamber and only the difference in current from the pair of chambers is measured. In this way as much as 98% of the gamma contribution to the ionization current in the outer chamber can in practice be cancelled out. An area monitor has 40 l ionization chambers and portable monitors have 1.2 or 0.3 l ionization chambers. The sensitivity of the area monitor can normally be switched from 0 to 1.5 $(MPC)_a$ tritiated water vapor up to 0 to 500 $(MPC)_a$. Further extension by two decades is possible. The most sensitive ranges on the portable monitors are 0 to 10 $(MPC)_a$ and 0 to 45 $(MPC)_a$ respectively, and both can be switched over two decades with five ranges. Sampling rates are high enough for the response times of the monitors to be less than one minute. (auth)

14420 (ANL–7029, pp 1-3) STUDIES WITH THE BROAD-RANGE MAGNETIC SPECTROGRAPH. Braid, T. H.; Chasman, R. R.; Erskine, J. R.; Friedman, A. M. (Argonne National Lab., Ill.).

An experimental investigation of actinide nuclei is being conducted with (d,p), (d,t), and (d,d′) reactions. Spectroscopic information such as energies, wave functions, and identities of intrinsic and collective states is being acquired. (auth)

14421 (ANL–7029, pp 4-8) THE 7.7-m BENT CRYSTAL SPECTROMETER. Smither, R. K.; Namenson, A. I. (Argonne National Lab., Ill.).

A combination gamma spectrometer which makes use of a Ge-diode gamma-ray detector in conjunction with the Argonne 7.7-m bent-crystal spectrometer is described. This combination spectrometer takes advantage of superior energy resolution (above 1 MeV) of the Ge diode while retaining the high signal-to-noise ratio and energy precision of the bent-crystal spectrometer. Examples of its performance are presented. (auth)

14422 (ANL–7265) BUBBLE CHAMBERS, 1964–1966. Derrick, M. (Argonne National Lab., Ill.). Oct. 1966. Contract W-31-109-eng-38. 49p. (CONF-660918–17). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From International Conference on Instrumentation for High Energy Physics, Stanford, Calif.

The developments in bubble chamber technology from 1964 to 1966 are reviewed. Topics included are new conventional chambers, picture production, high-field chambers, high-field or giant chambers, large bubble chamber projects, camera location, illumination and photography, and use of neon-hydrogen mixtures. (B.G.D.)

14423 (BNL–10991) CRYSTAL SPECTROMETERS FOR THE MEASUREMENT OF GAMMA RADIATION FROM NEUTRON CAPTURE. Schult, O. W. B. (Brookhaven National Lab., Upton, N. Y. Technische Hochschule, Munich (West Germany)). [1966]. Contract AT(30-2)-Gen-16. 5p. (CONF-661113–6). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Slow-Neutron Capture Gamma-Ray Conference, Argonne, Ill.

The use of focussing and flat crystal spectrometers for neutron capture–gamma ray spectrum measurements is discussed. The crystal spectrometers are then compared with the Ge(Li) spectrometer. (B.G.D.)

14424 (BNL–11031) DIGITIZED SPARK CHAMBERS IN HIGH ENERGY PHYSICS. Fischer, Joachim (Brookhaven National Lab., Upton, N. Y.). [1967]. Contract AT(30-2)-Gen-16. 63p. (CONF-670203–1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From International Conference on Electromagnetic Interactions at Low and Intermediate Energies, Dubna, USSR.

The properties of digitized wire spark chamber systems are compared to alternative techniques for track determination. Their advantages have led to a rapid increase in their application to high energy physics experiments. The characteristics of spark chamber planes and the problems associated with multiple tracks are briefly described. Factors affecting spatial resolution are discussed and results with various readout systems are compared. The angular and momentum resolution in chamber arrays attainable in experiments is presented, including the operation of spark chambers at $1/10$ atmospheric pressure for the reduction of multiple scattering in the system. The contemporary use of digitized spark chambers in high energy physics is illustrated with a list of over 40 experiments, many of them with a tentative layout and some system details. The advantageous employment of digitized spark chambers to particular experiments now and proposed is described. (auth)

14425 (BNL–50028) STATIC GAS COUNTERS FOR INIMICAL GASES. Christman, David R. (Brookhaven National Lab., Upton, N. Y.). Nov. 1966. Contract AT(30-2)-Gen-16. 8p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Two relatively simple counters for static counting of radioactive gases are described. In one counter the sample gas is contained in a thin-walled glass cylinder which separates it from the counting gas. The outer walls of the counter are made from oxygen-free copper tubing. All-glass counters, which are essentially ordinary internal gas counters, were also constructed. Efficiencies for both counter types are given. (P.C.H.)

14426 (BNWL-SA–927) ANTICOINCIDENCE SHIELDED MULTIDIMENSIONAL GAMMA-RAY SPECTROMETERS FOR LOW LEVEL COUNTING. Nielsen, J. M.; Perkins, R. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 16, 1966. Contract AT(45-1)-1830. 14p. (CONF-670304–1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Vienna, Austria.

A large anticoincidence shielded multidimensional gamma spectrometer is described, which is capable of measuring and providing energy spectra of some gamma emitters at levels of a few tenths of a disintegration per minute. (B.G.D.)

14427 (CEA-R–2962) ETUDE DES DETECTEURS A GAZ POUR NEUTRONS THERMIQUES FONCTIONNANT EN COLLECTION DE COURANT. (Gas Detectors for Thermal Neutron at High Counting Rates). Mai, Vuong Quan (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1966. 133p. (In French). Dep. mn.

Thesis. Submitted to Univ., Grenoble, France.

After a discussion of the current pulse formation theory in a cylindrical shape counter with and without gas multiplication, the schemes of pulse amplifier and level discriminator which have allowed verification of the above calculations and clarification of the part at high counting rates of the space charge in proportional counters are discussed. The theory of that phenomenon is given. The results obtained in a nuclear reactor with a counting-channel built with the above electronic circuits are also presented. (auth)

14428 (CEA-R–3067) LES COMPTAGES β DE FAIBLES ENERGIES EFFECTUES AU L.M.R. (Low Energy β Counts at the Radioactivity Measurement Laboratory of Grenoble). Duplaa, Anne-Marie; Chevalier, Michel; de Choudens, Henri (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Nov. 1966. 37p. (In French). Dep. mn.

Radioelements emitting β low energy are very useful in biology especially in labelled compounds. The counting method with liquid scintillators is very often used. The Radioactivity Measurement Laboratory of Grenoble uses for these measures a tricarb Packard. The samples to be counted are: tritiated water which is measured with a dioxane scintillator; animal textures which contain ^{14}C: these samples are dissolved in hyamine 10 X, then melted with a toluene scintillator; solid samples containing ^{14}C or ^{45}Ca (plant ashes): these samples are measured by suspension in scintillating mixtures. Gaseous samples of $^{14}CO_2$ are also counted, the gas is retained by hyamine, then mixed with a liquid scintillator. Counting of double labelled samples is also made on $^{45}Ca + {}^{32}P$ and $^{14}C + {}^{32}P$. The quenching corrections are made by internal standardization. (auth)

14429 (CONF-660221–, pp 366-70) POLARISED NEUTRON SPECTROMETER. Somanathan, C. S.; Murthy, N. S. Satya; Begum, R. J.; Srinivasan, B. S.; Murthy, M. R. L. N. (Atomic Energy Establishment, Trombay (India)).

A polarized neutron spectrometer that comprises a double-crystal neutron spectrometer together with a polarizing magnet, a guide field, a spin-flipping system, and an electromagnet is briefly described. The polarized neutrons are obtained by Bragg scattering from the (111) planes of a magnetized $Co_{92}Fe_8$ crystal. (D.C.W.)

14430 (IITRI-578P31-1) DEVELOPMENT OF NEUTRON SPECTROMETRY FOR CRITICAL ASSEMBLIES. Quarterly Report No. 1, June 20, 1966–December 31, 1966. Moler, Robert B.; Zagotta, William E. (IIT Research Inst., Chicago, Ill.). Jan. 26, 1967. Contract AT(11-1)-578. 37p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The development and testing of two neutron spectrometers is discussed. One spectrometer is a proton-recoil proportional counter designed to measure spectra in the energy range from 1 to 500 keV. This spectrometer is expected to exhibit improved resolution at high energies, reduced wall effects and lower gamma sensitivity over conventional proton-recoil spectrometers. The unique feature of this design is a ring of proportional counters in anticoincidence with the wall-less central counter. The other spectrometer is a ^{3}He sandwich spectrometer designed to measure spectra in the energy range from 100 keV to 14 MeV. This spectrometer is expected to reduce the effect of interfering reactions, to operate in high gamma fields (up to 10^6 R/hr) and to have, at the low neutron energies, improved resolution compared to conventional ^{3}He sandwich spectrometers. The unique feature of this design is that the ^{3}He converter gas is used as the filling gas of two identical proportional counters. (auth)

14431 (IN-1025) LINEAR-MOTION BENT-CRYSTAL GAMMA-RAY SPECTROMETER. Otteson, O. H.; Edwards, W. F. (Utah State Univ., Logan); Helmer, R. G. (Idaho Nuclear Corp., Idaho Falls). Jan. 1967. Contract AT(10-1)-1230. 56p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A new design of a bent-crystal spectrometer is described. The diffraction crystal moves only in translation (i.e., without rotation) as a means of changing the Bragg angle. Details of the design and construction of the spectrometer are presented including a discussion of the diffraction angle measuring system. The testing and calibration of the spectrometer is also described. The line broadening that results from the source being off the focal circle is discussed. For the special case of scanning the energy range of 88 to 620 keV without moving the source, the maximum increase in the line width is about 5% of the optimum width. Results are presented for the measurement of the gamma-ray energies in ^{182}W and ^{183}W. These energies, which were obtained with a quartz crystal, are generally within 0.02 keV of the quoted uncertainties on the previous measurements which were obtained with germanium crystals. (auth)

14432 (IS-1465) IMPROVED TECHNIQUE FOR TRACK PROFILE MEASUREMENT IN NUCLEAR EMULSIONS. Hall, J. E.; Zaffarano, D. J. (Ames Lab., Iowa). Nov. 1, 1966. Contract W-7405-eng-82. 7p. (CONF-660713-2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 6th International Symposium on Corpuscular Photography, Florence, Italy.

A method is described to permit photoelectric determination of mean track width of particles in nuclear emulsions, which involves slowly sweeping the image of a track across a narrow slit in front of a photomultiplier tube. The method consists of using a signal averaging digital computer to average and store the output signal from the photomultiplier tube. (B.G.D.)

14[illegible] ? (NP-16483) COMPARAISON DES DIFFERENTES TECHNIQUES DE COMPTAGE B^- DE QUELQUES RADIOELEMENTS. (Comparison of Different Techniques of Counting Beta Particles in Several Radioelements). Aubouin, G. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Jan. 1965. 8p. (In French). DTIE.

The counting yields of the radioisotopes ^{35}S, ^{32}P, ^{204}Tl, ^{90}Sr, ^{90}Y, ^{45}Ca, ^{42}K, and ^{59}Fe were determined. The devices used were a Geiger-Muller counter of the 13 A6 type, a plastic scintillator of the Meinke type, a labyrinth plastic scintillator, and a tri-carb liquid scintillation spectrometer. The results are tabulated and show that in the case of the liquid scintillator the counting yield as a function of maximum energy of the β^- passes through a maximum in the vicinity of 850 keV. (J.S.R.)

14434 (NP-16500) COURBES DONNANT LE POUVOIR D'ARRET D'UN CRISTAL NaI(Tl) POUR DES ENERGIES DE PHOTONS γ COMPRISES ENTRE 0,01 MeV ET 10 MeV. (Curves Giving the Stopping Power of a NaI(Tl) Crystal for γ Photons in the Energy Range 0.01 to 10 MeV). Note No. MNMR/2. Pla, E. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). June 1965. 15p. (In French). Dep. mn.

The formulas for the stopping power of a NaI(Tl) crystal for γ photons at energies between 0.01 and 10 MeV were derived. The formulas were evaluated and numerical results were tabulated and graphed. (J.S.R.)

14435 (NP-16534) MEDICION DE RADIACION β DE BAJA ENERGIA Y BAJA ACTIVIDAD. (Measurement of Low Energy and Low Activity β Radiation). Navarro Cuevas, Domingo (Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Ciencias). 1965. 105p. (In Spanish). Dep. mn.

Thesis.

The design of an apparatus for the measurement of low energy and low activity β radiation with the imposition of extreme limitations on the background count was described. A detector of the scintillation type was chosen. The interaction of β and γ radiation with matter is first considered. The formulas to calculate the shielding necessary for the background reduction and to calculate the energy absorbed by the phosphor are given. The most important properties of the known phosphors are outlined. The photomultiplier tube used in the detection instrument is studied with separate consideration given to each part of the tube as well as to the yield and the counting efficiencies of the photoelectric materials and of the different types of dynodes. The obscurity currents were also studied. The criteria for the selection of the detector are outlined. (J.S.R.)

14436 (ORNL-TM-1669) DESCRIPTION OF FACILITY RADIATION AND CONTAMINATION ALARM SYSTEMS INSTALLED IN THE METALS AND CERAMICS LABORATORY, BUILDING 4508. Russell, J. A., Jr.; Knowles, D. J. (Oak Ridge National Lab., Tenn.). Dec. 6, 1966. Contract W-7405-eng-26. 26p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Facility radiation and contamination alarm systems were installed in the Metals and Ceramics Laboratory Building 4508 to continuously and automatically monitor neutron radiation (by three neutron rate-burst detectors) and air contamination (by five alpha and three beta-gamma constant air monitors) in the entire facility. These instruments and other components in the network provide health physics monitoring information, sound local alarms when abnormal conditions occur, and indicate the abnormal conditions on a central panel board. Operating personnel are first given warning when air-borne contamination detected by one of the air monitors reaches a preset caution level. A second warning is given when the high-level set point is reached. The neutron detectors operate rate or burst alarms when the alarm levels are exceeded. The building evacuation system operates automatically when two or more alpha air monitors detect a high level of air contamination or when two or more neutron monitors detect a neutron burst or high rate. (auth)

14437 (ORO-3345-2) CHEMICAL STRUCTURAL STUDIES BY NUCLEAR TECHNIQUES. Yearly Progress Report, March 1–November 30, 1966. Ellis, William H.; Ortabasi, Ugur (Florida Univ., Gainesville. Dept. of Nuclear Engineering Sciences). Dec. 1, 1966. Contract AT(40-1)-3345. 34p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The operational testing and performance of a system for studying the microstructure of liquids and solids by the use of extranuclear perturbation of angular correlation measurements are reported. Time dependent angular correlation measurements were performed with ^{181}HF polycrystalline metallic powder and liquid oxychloride sources with time dependent external field effects being observed in the case of the polycrystalline metal source. The application of relatively thin 3mm thick cylindrical type lithium-drifted germanium diodes for small-time jitter low-energy gamma coincidence spectrometry was evaluated. (B.G.D.)

14438 (SLAC-PUB-252) STREAMER CHAMBER DEVELOPMENTS AT SLAC. Odian, A. (Stanford Linear Accelerator Center, Stanford Univ., Calif.). Oct. 1966. Contract AT(04-3)-400. 11p. (CONF-660918-18). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From International Conference on Instrumentation for High Energy Physics, Stanford, Calif.

The development of several streamer chamber systems at SLAC are discussed. Topics included are ionization measurements, problems with large streamer chambers, treating large streamer chambers as transmission lines, photography, and high voltage technology. (B.G.D.)

14439 (SLAC-PUB-255) SYSTEMS FOR THE HUMMINGBIRD AT SLAC. Dickens, C. (Stanford Linear Accelerator Center, Stanford Univ., Calif.). Jan. 1967. Contract AT(04-3)-515. 10p. (CONF-670105-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From International Conference on Flying Spot Devices, Munich, Germany.

The building and subsequent incorporation into the IBM 360/50 system of the Hummingbird I Scanner are discussed. Topics included are general description, basic program organization, basic programming control, basic output and I/O interface. Additional projects are also included: CBX system, N-P system, and on-line SUMX. (B.G.D.)

14440 (UCRL-17120) BERKELEY ON-LINE CRT FILM SCANNERS. Kenyon, Raymond G. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 13, 1966. Contract W-7405-

eng-48. 23p. (CONF-660947-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From AEC Information Meeting, New York.

Two CRT film scanners have been developed at the Lawrence Radiation Laboratory, Berkeley. The first is an on-line automatic spark-chamber film scanner called SASS. The second is an on-line automatic film scanner which scans pictures of bacterial colonies. (auth)

14441 (UJV-1601) MOZNOSTI MERENI INTEGRALNICH TOKU RYCHLYCH NEUTRONU PO DOBU 2-20 LET AKTIVACNI METODOU. (Various Measurements of Integral Currents of Fast Neutrons by Means of 2-20 LET Activation Method). Kadlec, V. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1966. 28p. (In Czech). DTIE.

The activation method of measuring integral neutron fluxes commonly used for times of up to 1 year is possibly also feasible for longer times. Of the flux-measuring reactions described in the literature, only the $^{63}Cu(n,\alpha)^{60}Co$ and the $^{232}Th(n,f)^{137}Cs$ reactions give products of long enough half life for consideration. To avoid the complications of compound formation, reactions leading to inert products are chosen. From a table of nuclear reactions, those producing radioactive isotopes of the rare gases with half lives of 2 to 20 years by means of (n,γ), (n,p), or (n,α) reactions were selected and discussed. Whether or not these reactions may be used will depend partly on their cross sections, not all of which are known accurately. The limitations of these reactions for flux measurements are discussed; for example, a factor that must be taken into account is the target purity required. (TTT)

14442 RADIATION SURVEY METER CALIBRATOR. Higgins, G. S.; Wallace, C. R. (Army Metrology Lab., Sacramento, Calif.). Health Phys., 12: 1626-7(Nov. 1966).

The design and performance of a system of rotatable lead attenuators for calibration and variation of the intensity of a gamma source is described. The source is being used for the calibration of gamma survey meters. (B.G.D.)

14443 SMALL CONTINUOUS AIR MONITOR FOR FIELD OR LABORATORY USE. Block, S.; Beard, E.; Barlow, O. (Univ. of California, Livermore). Contract W-7405-eng-48. Health Phys., 12: 1609-16(Nov. 1966). (UCRL-14415).

Portable atmospheric monitoring equipment is sometimes required in remote areas, to continuously monitor the air for β-emitting isotopes. A system was developed that is battery powered, small and lightweight, and can operate as a continuous monitor at 1 ft^3/min for 8 hr. The electronics is transistorized on printed circuit boards. An alarm trip circuit can be set at predetermined levels above background. Beta sources of E_{max} from 0.3 to 2.3 MeV and a ^{207}Bi conversion electron source were used to calibrate the system. Interference from concentrations of 300 pc/m^3 of radon-thoron daughter products was considered and found to have little effect when compared to MPC quantities of ^{131}I. Using charcoal-impregnated, glass fiber filter paper, the monitor can detect 1 MPC of ^{131}I in 10 min. (auth)

14444 THE ABSOLUTE COUNTING OF THE ACTIVITY OF α EMITTERS. A REVIEW OF THE EXPERIMENTAL TECHNIQUES. Murrenhoff, Alexander (Kernforschungsanlage, Juelich, Ger.). Z. Instrum., 74: 283-91(1966). (In German).

There are 2 different types of absolute α activity measurements. One is primary, and the other is secondary. The procedures of the primary type are considered, where either the actual decay rate or an exactly known fraction of the true decay rate is measured. This information is important in estimation of reaction cross sections of an nuclear reaction from the product activity if the flux of reacting particles and the number of reactant atoms in the target are known, or for the estimation of particle flux, or the estimation of the concentration of target particles that react (activation analysis), or for the quantitative chemical analysis of radioactive materials, using radiometric procedures. Technical procedures required for absolute α counting by a 2π counter, a counter with low counting geometry, counters with 4π liquid scintillation counter, and α/γ coincidence counter are discussed. Ever since the development of these numerous techniques studies were carried out to compare with one another, and ascertain the independence of systematic errors, and to improve them. The results of these studies indicate that today a relative accuracy of a few fractions of a % is possible in measurement of absolute α activity. References cited, 43. (BBB)

14445 IN-LINE HOLOGRAM SYSTEM FOR BUBBLE-CHAMBER RECORDING. Ward, J. H.; Thompson, B. J. (Technical Operations Research, Burlington, Mass.). J. Opt. Soc. Amer., 57: 275-6(Feb. 1967).

A feasibility experiment is described in which simulated particle tracks in a bubble chamber were photographed using an in-line Fraunhofer hologram method. (B.G.D.)

14446 A NEW TYPE OF QUANTOMETER (GAUSS QUANTOMETER) FOR MEASURING BREMSSTRAHLUNG BEAM ENERGIES. Komar, A. P.; Kruglov, S. P.; Lopatin, I. V. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 36: 1710-17(Sept. 1966). (In Russian).

The design, construction, and performance of an automatic integrating quantometer for direct measurement of the energies of bremsstrahlung beams, analogous to the quantometer of R. R. Wilson (Nucl. Instr., 1,101, 1957) is described. The suitability of different numerical integration formulas for integrating the copper transition curve is discussed, and it is concluded that Gauss' formula is the most advantageous. The described instrument employs seven copper absorbers with thicknesses ranging between 0.405 and 2.863 cm and gaps between them ranging between 0.104 and 0.284 cm. The absorber thicknesses and gap widths were selected in accordance with Gauss' integration formula. The instrument can be hermetically sealed and is designed to accommodate a 10 cm diameter beam. When filled with air at atmospheric pressure the sensitivity of the instrument is 0.877×10^{-19} C/MeV. The sensitivity was found experimentally to vary by less than 2% for bremsstrahlung beams with maximum energies from 15 to 650 MeV. The maximum beam power that can be measured with air filling is 10^{-3} W/cm^2 at a pulse rate of 50 Hz; by using a rare gas filling the maximum power that can be measured can be increased by a factor of 10^3. The instrument can also be used to measure the powers of high energy electron beams. (ATD)

14447 A SIMPLE SENSITIVE RADIOACTIVE SCANNER FOR THIN-LAYER CHROMATOGRAMS. Ravenhill, J. R.; James, A. T. (Unilever Research Lab., Sharnbrook, Bedford, Eng.). J. Chromatogr., 26: 89-100(Jan. 1967).

The construction of a cheap and versatile thin-layer plate scanner is described. The instrument was fitted with count integration to facilitate more accurate quantitative determinations. Examples are given showing the capabilities of the instrument together with full operational procedures. (auth)

14448 CURRENT-VOLTAGE CHARACTERISTICS OF SECONDARY ELECTRON EMISSION MONITORS. Brinkmann, E.; Hellwig, G. (Univ., Mainz). Nucl. Instrum. Methods, 48: 163-6(1967). (In German).

An intrepretation is given of the behavior of the current-voltage characteristic (dependence of the SEM current on the feed voltage at constant primary electron energy and constant primary electron current density). The experimental study showed that the behavior of the current-voltage characteristics of an SEM can be assigned to the interaction of the reflection of secondary electrons on the collector foils and the mean yield limited by these electrons at the emitter foils. (J.S.R.)

14449 MAGNETIC BETA-RAY SPECTROMETER WITH DOUBLE FOCUSING. Rezanka, Ivan; Spalek, Antonin; Kuklik, Ales; Frana, Jaroslav (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Cesk. Cas. Fys., 17: No. 1, 43-54 (1967). (In Czech).

A beta-ray spectrometer with double focusing, having radius of the stable orbit of 50 cm, was built. The magnetic field was obtained by using an iron magnet of the mushroom type 144 cm in diameter. The maximum resolution was 0.06%. The energy calibration is reproducible to 0.1% when stabilizing the spectrometer field. (auth)

14450 SCINTILLATION PROCESS IN CsI(Tl). Rehmann, Wilhelm; Scharmann, Arthur (Univ., Giessen, Ger.). Z. Naturforsch., 21a: 1684-9(Oct. 1966). (In German).

Luminescence decay times of CsI and CsI(Tl) crystals with different Tl concentrations were measured after excitation with uv, electron, and ion pulses. Taking the model of Bonanomi and Rossel as a basis, the results are explained by two energy transfer mechanisms: the fast one is caused by excitons, the slow one by electron–hole pairs. (auth)

14451 PORTABLE DEVICE FOR THE CONTROL OF ALPHA-ACTIVE SURFACE CONTAMINATIONS. Steuer, J. (Staatliche Zentrale fuer Strahlenschutz, Berlin). Isotopenpraxis, 2: 451-3 (Dec. 1966). (In German).

A portable fully transistorized device for determining alpha-active surface contaminations is described which is operated by 7 proportional counters of VA-Z-520 type. A mechanical register serves for improving the low-level reading; in the case of high-level activities a rate meter is used. The alpha-active surface contaminations permissible according to the Decree of Radiological Protection may be controlled by applying this device. Calibration is made by using a ^{239}Pu flat standard source. The device is also suited for measuring the beta- and gamma-radiation. For this purpose, the part of the probe including the counters has to be substituted by the beta-gamma head including 7 counters of Va-Z-310 type. (tr-auth)

14452 MEASUREMENTS OF THERMAL NEUTRON FLUX AND CADMIUM RATIO BY GOLD ACTIVATION. Bugorkov, S. S.; Krivohatskii, A. S.; Petrzhak, K. A.; Skovorodkin, N. V.; Sorokina, A. V. At. Energ. (USSR), 21: 508-9(Dec. 1966). (In Russian).

The thermal-neutron flux may be measured by activating a gold foil on the basis of the $^{197}Au(n,\gamma)^{198}Au$ reaction; the effect of the resonance portion of the cross section is determined by irradiating the gold foil with and without a cadmium shield. In order to obtain a correct cadmium ratio, the neutron density spectrum must remain the same (i.e., the foil must be transparent for epicadmium neutrons.) The activity may be measured by a β-γ coincidence counter or by a 4π β counter, carrying out the measurement on an aliquot part of the dissolved foil. This latter method was simplified by eliminating the dissolution of the activated specimen, dissolving and aliquoting the foil before activation. The weight of the gold used could be determined with an error of <1%. Absorption of the β particles by the aluminum support was taken into account in the calculations, using a special calibration curve. Measurement of the radiative capture cross section of the $^{89}Y(n,\gamma)^{90}Y$ reaction by this method yielded results in agreement with previously reported data throughout the whole energy range. (TTT)

14453 SIMPLE LOW-BACKGROUND BETA COUNTER. Feher, Istvan; Kroo, Erik. KFKI (Kozp. Fiz. Kut. Int.) Kozlem., 15: 49-54(1967). (In Hungarian).

A beta detector of 25-mm-dia surface, consisting of 0.5-mm-thick plastic scintillator with a 10-mm-thick truncated plexiglas cone as light-guide, developed for use with a GOM ND-117 type scintillation probe is described. Operating the probe in combination with a GOM NK-108 type energy selective counter and using appropriate shielding, beta particles of maximum $\geq$ 0.3 MeV energy are detected with energy-dependent efficiency of 18 to 50% when the background intensity is ~5 cpm. Possible applications of this low-background counter are suggested. (auth)

14454 ANALYSIS OF THE PERFORMANCE OF AUTOMATED, HIGH RESOLUTION MAGNETIC HODOSCOPES. Bacon, D. F.; Nash, W. F. (Univ. of Nottingham, Eng.). Nucl. Instrum. Methods, 47: 353-60(1967).

A general theoretical treatment is presented of the automatic hodoscope used in conjunction with magnetic deflections for momentum analysis, with particular reference to cosmic ray measurements using solid iron magnets. A method is developed using intermediate variables which is shown to simplify the calculation of the performance of an instrument. It is shown that such instrumentation is more suited to the selection of events above or below a given momentum, than for measurement over a wide range of momentum. With a small increase in complexity, it is shown that a correction for the effect of variation of incidence angle may be achieved. (auth)

14455 A PROGRAM OF A COMPUTER (KDC-I) FOR AUTOMATIC DATA PROCESS OF PULSE HEIGHT SPECTRA IN EXPERIMENTAL NUCLEAR PHYSICS. Kokame, Jun. Bull. Inst. Chem. Res., Kyoto Univ., 44: 367-80(Sept. 1966).

A program was developed for the KDC-1 computer to automatically analyze spectra obtained from multichannel pulse-height analyzers which store information on the energy distribution of particles emitted from nuclear reactions. The code is capable of making an automatic search of peaks in the spectrum, a proper background subtraction, and calculations of differential cross sections in laboratory or center-of-mass systems with the statistical error. The performance of the code is given with several examples. Some limiting conditions for the code are: (1) the maximum number of channels to be analyzed must be less than 640; (2) standard full-width at half-maximum of peaks must be given; and (3) the maximum count in each channel must be less than 10^6. (auth)

14456 SOME SPECIAL PROPERTIES OF GEIGER-MUELLER COUNTER TUBES. Voedroes, D.; Miklos, K. (Medizinisch-Radiologische Forschunginstitut, Budapest). Radiobiol. Radiotherap., 7: 473-9(1966). (In German).

A check of several simultaneously produced Geiger-Muller counter tubes showed that there are considerable differences in plateau slope, dead time, sensitivity, and dependence on direction departing from the data of the producer. It is absolutely necessary for exact measurements and special measuring arrangements to do one's own control measurements. (auth)

14457 7.7 M BENT CRYSTAL SPECTROMETER AT THE 184 INCH CYCLOTRON. Crowe, Kenneth M.; Shafer, Robert E. (Univ. of California, Berkeley). Contract W-7405-eng-48. Rev. Sci. Instrum., 38: 1-10(Jan. 1967). (UCRL-16637).

The design, operation, and calibration of a 7.7 m DuMond geometry bent crystal spectrometer, constructed at the 184 in. Cyclotron for the study of mesonic x rays, are described. The application of crystal diffraction techniques to mesonic x-ray measurements is briefly discussed. (auth)

14458 USE OF CRYSTAL DIFFRACTION WITH Ge DIODE DETECTOR FOR HIGH RESOLUTION GAMMA-RAY SPECTROSCOPY. Smither, R. K.; Namenson, A. I. (Argonne National Lab., Ill.). Rev. Sci. Instrum., 38: 52-65(Jan. 1967).

The Argonne 7.7 m bent crystal gamma-ray spectrometer is combined with a lithium drifted Ge diode detector to perform high resolution gamma-ray spectroscopy on complicated neutron capture gamma-ray spectra. The system combines the energy precision of the bent crystal spectrometer with the high resolution of the Ge diode. The system is most useful in the 1-3 MeV energy range where both the precision and energy resolution obtained by the combined system frequently are from 3 to 10 times those of either the bent crystal or the Ge diode used individually. A 50-fold improvement in the signal-to-background ratio is obtained through the use of the combined system. The use of the system is illustrated by $^{113}Cd(n,\gamma)^{114}Cd$ spectra. The Argonne system is compared with other possible crystal diffraction arrangements and with coincidence and anticoincidence techniques for improving the quality of the (n,γ) measurements. The application of the Argonne system to the comparison of (n,γ) transitions with gamma transitions following radioactive decay is discussed. New values for the strong gamma transition associated with the decay of ^{137}Cs and ^{60}Co are quoted along with a more precise value (1294.35 ± 0.30 keV) for the gamma ray associated with the decay of ^{41}A. Improvements in the Argonne system are described and a proposed extension of the system for precision energy measurements in the 2-5 MeV range is discussed. (auth)

14459 CASTING FORMVAR FILMS ON WATER. Merritt, J.; Agazzi, E. J. (Shell Development Co., Emeryville, Calif.). Rev. Sci. Instrum., 38: 127(Jan. 1967).

Thin Formvar films (500-5000 Å) are frequently used for proportional counter windows. One of the problems of casting Formvar films on water is that the solvent (1,2 dichloroethane) for the Formvar is more dense than water and it is thus difficult to float the solution on a water surface. Henke described a procedure for overcoming this difficulty. A modification of this procedure is presented whereby films of more uniform thickness are produced. (B.G.D.)

14460 LIQUID SURFACE ELECTROSTATIC PRECIPITATOR. Strindehag, Ove M. (Aktiebolaget Atomenergi, Studsvik, Sweden). Rev. Sci. Instrum., 38: 95-9(Jan. 1967).

A liquid surface electrostatic precipitator for fission product monitoring is described. The precipitation electrode is made of a double wire arrangement which guides a liquid flow. Collected activities are detected by means of a Čerenkov detector. The precipitator was operated with water as the precipitation medium at a flow of about 0.5 cm^3/sec. Experiments indicate a precipitation efficiency of 70% and a detector efficiency for ^{86}Rb of up to 80%. (auth)

14461 SIMPLE CONTACTLESS METHOD FOR MEASURING DECAY TIME OF PHOTOCONDUCTIVITY IN SILICON. Lichtenstein, R. M.; Willard, H. J. Jr. (Rensselaer Polytechnic Inst., Troy, N. Y.). Rev. Sci. Instrum., 38: 133-4(Jan. 1967).

A method is described for measuring decay time of photoconductivity in silicon. The technique is to induce eddy currents in a silicon disk by means of an alternating magnetic field and to monitor the power absorbed by the sample. (B.G.D.)

14462 SCINTILLATION METHOD OF MEASUREMENTS OF THE RADIOACTIVITY OF ^{55}Fe. Lada, Andrzej; Radoszewski, Tomasz (Inst. of Nuclear Research, Warsaw). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/4, 12p. (CONF-661012-36). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

The scintillation method of measurements of the radioactivity of the ^{55}Fe solution was investigated. The double-channel 4π scintillation counter containing two photomultipliers (EMI-9514S), light-pipe and two plastic scintillators (NE-102) in sandwich form, with the source between them, was used as the detector. The source was prepared on the light transparent mylar foil and covered by that same. The counting equipment was used to count the pulses from the detector in the parallel system and also in coincidence. The scintillation counter was cooled up to -20°C, because of the dark current from the photomultipliers. The anode characteristics of the scintillation counter for ^{55}Fe and for the background are given, which allowed to choose the proper working parameters. Having full absorption of the Auger electrons in the mylar foil, the measurements of the counting efficiency for K-X rays as a function of the thickness of the plastic scintillators

(from 0.45 mm to 3.5 mm) are presented. The proper thickness of the scintillators which ensured full absorption of K-X rays, was chosen for further measurements. The measurements of the amount of K-X rays from the sample were performed by taking the discrimination curves (for constant EHT and gain of amplification) and extrapolation to the zero level of discrimination. The amount of the counted K-X rays from the sample was taken as a basis to calculate the radioactive concentration of the ^{55}Fe solution. The absorption correction for K-X rays in the mylar foil was defined experimentally. The results of measurements in the parallel system of IAEA and Amersham standard solutions were compared with the figures given by the producers. (auth)

14463 DEVICE FOR DETECTING AND/OR MEASURING THE INTENSITY OF MIXED RADIATION. Droulers, Yves; Mas, Pierre; Sciers, Paul (to Commissariat a l'Energie Atomique). British Patent 1,054,798. Jan. 11, 1967. Priority date Sept. 22, 1962, France.

A device for measuring the intensity of mixed radiation and which may also be used to indicate the type of radiation in a reflector or moderator fluid, such as light or heavy water or other organic liquids of a nuclear reactor is described. The instrument consists of a stainless steel watertight casing, a core in the casing, and a thermocouple. The cold junction of the thermocouple is subject to the ambient temperature of the reactor medium. The core in the casing is heated by decelerating neutrons and electrons from the reactor medium. The core is heated in accordance with the intensity of the radiation. The hot junction of the thermocouple is in contact with the core and the temperature difference between the thermocouple junctions provides a signal which is an indication of the intensity of the radiation. Graphite cores are sensitive to all kinds of radiation. Lead and Bi are sensitive to γ rays and polyethylene and polystyrene are sensitive to the sum of fast neutrons and γ rays. Consecutive measurements made with different cores at the same place give an indication of the energy corresponding to each kind of radiation. (F.S.)

14464 EFFICIENCY OF A LIQUID SCINTILLATION COUNTER. Paligoric, D.; Dobrilovic, L.; Bek-Uzarov, D. (Boris Kidric Nuclear Inst., Vinca, Yugoslavia). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/29. 16p. (In Russian). (CONF-661012-40). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

The energy and geometric $4-\pi$ counting efficiency of a liquid scintillation counter is discussed. The beta-particle energy which is absorbed in the scintillation solution and which is necessary for the formation of an average of one photoelectron on the photocathode is the energy detection threshold. The energy threshold is determined by the difference in the maximum tritium energies as obtained from spectrum measurements of detectors comprising one photomultiplier and two photomultipliers in coincidence circuit. The difference is due to the fact that the scintillation counter with one photomultiplier counts the pulses produced by one or several electrons, while the two-photomultiplier counter can only count pulses from two or more photoelectrons. The difference in the maximum energies measured with and without the system connected to a coincidence circuit corresponds to the detection sensitivity threshold of the photomultiplier connected to the coincidence circuit and not to that of the photomultiplier of the pulse analyzer. The difference in the maximum energies of the tritium in the case of each of the photomultipliers is due in particular to the different energy detection thresholds. If the photomultipliers are in coincidence, the threshold of the counter system is the sum of the thresholds of the individual counters. The influence of geometrical factors was investigated by preparing spherical glass phials, into which the liquid scintillator with the radioactive solution was poured. These spherical specimens had different diameters and a solution of an identical specific scintillator activity (i.e., the same number of disintegrations per gram of scintillator solution) was poured into them. The specimens were set up in the same position. The photomultiplier axis passed through the center of the phial and the photocathode was placed in a tangential plane on the surface of the phial. In this way it was possible to observe the geometrical effectiveness with spheres of different diameters. (auth)

14465 SPECTROMETRIC ALPHA SOURCES AND THEIR APPLICATION IN DETERMINING THE BASIC PARAMETERS OF SPECTROMETERS AND SEMICONDUCTOR DETECTORS. Stepanov, E. K.; Tyutikov, N. V. Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/74, 16p. (In Russian). (CONF-661012-44). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

The use of alpha sources for determing the basic parameters of spectrometers and semiconductor detectors is discussed. The spectrometric characteristics of the sources are defined and their values determined for the measurement of a given spectrometer parameter. The investigations were carried out with ^{233}U, ^{239}Pu, ^{241}Am and ^{210}Po alpha sources and with ^{226}Ra and RaTh(^{228}Th) radon-free sources, the radionuclides being prepared by different methods. The spectra of the sources were recorded by means of an alpha spectrometer with a semiconductor and having a total energy resolution of 20–25 keV. (auth)

14466 CALIBRATION OF RADIONUCLIDES WITH A COINCIDENCE SYSTEM USING A PRESSURIZED PROPORTIONAL $4\pi-\beta$ DETECTOR. Baerg, A. P.; Bowes, G. C.; Adams, R. J. (National Research Council, Ottawa). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/12, 15p. (CONF-661012-31). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

Radionuclide calibrations with a $4\pi\beta-\gamma$ coincidence system are described in which a pressurized gas-flow counter is used in the β-channel. This detector is operated in the proportional region and is of the small pill-box type, slide operated and modified for use at pressures up to 75 atmospheres. Flow operation with purified gas is necessary to prevent gain instability resulting from gas deterioration effects. This entails the use of a precision density regulator to maintain stable gas multiplication. The energy resolution of the small pressurized β-detector is adequate to permit absolute calibrations of some nuclides difficult to standardize with counters operated at atmospheric pressure or by other means. In particular, the calibration of the electron capture species ^{197}Hg will be described in which coincidences with γ-x-ray sum pulses in the γ-channel are used as a measure of the β-detector efficiency for low energy Auger-photon cascades. (B.G.D.)

14467 ABSOLUTE COUNTING OF THICK SOURCES BY THE $4\pi\beta-\gamma$ COINCIDENCE METHOD. Menke, H.; Fahland, J. (Univ. Mainz). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/18, 16p. (CONF-661012-38). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

For determination of fission yields, nuclear reaction cross-sections or decay branching ratios the disintegration rate of the investigated nuclide must be known with a precision of 2–3%. Application of radiochemical techniques requires the addition of carrier amounts between 1 and 20 mg. The absolute activity is then usually measured by counting the sample in a secondary calibrated counter. The direct absolute counting of such thick samples by the $4\pi\beta-\gamma$ method was investigated using a number of nuclides with different decay schemes and sample weights between 10 and 50 mg (about 4–20 mg/cm^2 respectively). $4\pi\beta-\gamma$ coincidence counting requires a β-counting efficiency near unity. As this condition cannot be met when using samples with carrier amounts, especially for low β-energies, an extrapolation method was used. The efficiency of the $4\pi\beta$-counter was varied by means of the applied high voltage. The β-, the γ- and the coincidence counting rates (N_β, N_γ and N_C respectively) were measured for each variation. Both N_β and the apparent disintegration rate $N_0' = N_\beta \cdot N_\gamma / N_C$ were then plotted versus the factor N_C/N_γ and extrapolated to $N_C/N_\gamma = 1$. For this quantity both plots should yield the disintegration rate of the sample. These disintegration rates were compared with the known disintegration rates (if calibrated solutions were used) or with $4\pi\beta-\gamma$ coincidence measurements of carrier free samples. The results show that this method can well be used for the above-cited purposes without any further corrections. (auth)

14468 PERFORMANCE PARAMETERS OF SOME NEW EFFICIENT AND HIGHLY SOLUBLE SOLUTES FOR LIQUID SCINTILLATORS. Kowalski, E. (Univ., Bern); Anliker, R.; Schmid, K. 14p. (CONF-660612-5). DTIE. Gmelin, AED-CONF-66-188-10.

From Symposium on Organic Scintillators, Argonne, Ill.

The results of systematic investigations on unsubstituted and alkyl-substituted benzoxazole, benzoxazolyl-thiophene, and 1,3,4-oxadiazole derivatives for use as liquid scintillators are presented. The measurement of the quoted physical and practical properties of some selected compounds of these series indicate them to be very efficient primary or secondary solutes for liquid and also for plastic scintillators. (B.G.D.)

14469 DIGITIZED WIDE-GAP WIRE SPARK CHAMBER. Chikovani, G. E.; Laverriere, G. C.; Schuebelin, P. (CERN, Geneva). 13p. (CONF-660918-13). DTIE. Gmelin, AED-CONF-66-285-1.

From International Conference on Instrumentation for High Energy Physics, Stanford, Calif.

A possibility for digitizing a wide-gap spark chamber by means of magnetostriction is presented. The high-tension central electrode consists of two perpendicular information planes; two other

information planes are grounded. A special system is designed for the read-out of the high-tension electrodes. The problem of reducing memory and recovery time was studied. Henogal with admixture of 5% of argon and 6×10^{-3}% of freon as quencher gave a memory time of ~1 μsec and a recovery time smaller than 5 msec. The properties were studied on a model of $40 \times 40 \times 20$ cm^3, and chambers of $150 \times 150 \times 20$ cm^3 were constructed. (auth)

14470 NEUTRON DETECTOR OR DOSIMETER. (to The Boeing Co.). British Patent 1,056,012. Jan. 25, 1967. Priority date Feb. 27, 1964, United States.

A neutron detector/dosimeter is described which is comprised of a radiation sensitive element of nickel oxide doped with Boron-10 or lithium-6 which transmutes when subjected to neutron radiation and thereby causes the electric resistivity of the element to vary. (B.G.D.)

Radiation Dosimeters

14471 (CONF-660221–, pp 339-44) RESPONSE OF PLASTIC SCINTILLATORS TOWARDS FAST NEUTRONS AND ITS APPLICATIONS. Chatterjee, Arun; Ghose, A. M. (Bose Inst., Calcutta (India)).

It is shown that the high-energy portion of the pulse height distribution curve for plastic scintillators can be easily explained in terms of Birk's semi-theoretical formula. (B.G.D.)

14472 (N-66-36055) SOLID CHEMICAL RADIATION DOSIMETER. Semiannual Report, Potsaid, Majic S.; Shibata, S. (Massachusetts General Hospital, Boston, Radiology Dept.). July 1, 1966. 16p. (NASA-CR-77801). CFSTI $3.00 cy, $0.65 mn.

The effects of temperature and x-irradiation strength on the acid production and color change in the Halogenated compound-Azo dye-Paraffin matrix, HAP, solid chemical dosimeter system were experimentally investigated. For the acid production studies a liquid paraffin was used in place of a solid paraffin to make the acid extraction more complete and reproducible. Chloroform was the halogenated compound used, and the dye was dimethylaminoazobenzene. The solid state of the mixture was obtained by cooling in a deep freeze. For the light transmittance measurement studies, paraffin was blended with chloroform and the dye at 65 to 70°C in making the translucent solid slabs. Data are given, showing the correlation of acid production with electron density and atomic number. The influences of physical state factors (concentration and type of organic compound used) on the peak response are also discussed. Several data curves depicting the radiation and concentration effects on the acid production and color changes sensitivity are given. (STAR)

14473 (N-67-10874) BASIC RESEARCH IN SEMICONDUCTOR DETECTOR-DOSIMETER CHARACTERISTICS, AS APPLIED TO THE PROBLEMS OF WHOLE BODY DOSIMETRY. Annual Progress Report. Crawford, George W. (Southern Methodist Univ., Dallas, Tex.). Sept. 1966. 82p. (NASA-CR-79718). CFSTI $3.00 cy, $0.65 mn.

The preparation of lithium-drifted semiconductor nuclear particle detectors is discussed in detail. The associated theory is reviewed, including basic material, diffusion, p-n junctions, drift, and operation, and the preparation and experimental results of the detector are presented. It was concluded that preparation and use of the detector are both feasible and desirable. It was pointed out that excellent agreement can be obtained between experimental and theoretical determinations of stopping power, average excitation energy, and electron hole pair formation energy for silicon. Summary reports are also included on other phases of basic research in semiconductor detector–dosimeter characteristics, including charge–pulse response of silicon detectors, detector lifetime behavior studies, stopping power measurements, and correlation between biological response and dose measurement. (STAR)

14474 APPLICATION OF GAMMA RAYS AND FAST NEUTRONS FROM IONIZATION CHAMBERS FILLED WITH A LIQUID DIELECTRIC TO PRACTICAL DOSIMETRY. Blanc, D. (Faculte des Science, Toulouse); Mathieu, J.; Patau, J. P.; Francois, H.; Soudain, G. Health Phys., 12: 1589-94(Nov. 1966). (In French).

Cylindrical ionization chambers filled with liquid n-hexane, are stable dosimeters with a large sensitive volume. The ionization current is a linear function of the dose rate absorbed in the liquid. The sensitivity is $5 \cdot 10^{-7}$ rad/sec. (auth)

14475 IMPROVED CLEANING TECHNIQUE FOR SILVER METAPHOSPHATE GLASS DOSIMETERS. Kathren, Ronald L. (Univ. of California, Livermore). Health Phys., 12: 1624-6(Nov. 1966). (UCRL-14726).

A cleaning procedure for silver metaphosphate glass dosimeters is described for removal of surface soil. The procedure consists of: dip in dilute 10% HCl, rinse in water with ultrasonic agitation; rinse in methanol with ultrasonic agitation; and dry, either by natural evaporation of (preferably) with laboratory tissue (non-silicone). Vacuum drying is an additional desirable refinement. (B.G.D.)

14476 THERMOLUMINESCENT DOSIMETRY MONITORING SYSTEM FOR THE NATIONAL REACTOR TESTING STATION. Cipperley, Foster V. (Atomic Energy Commission, Idaho Falls, Idaho). Health Phys., 12: 1637-8(Nov. 1966).

The use of lithium fluoride thermoluminescent dosimeter system for the personnel of the National Reactor Testing Station is briefly discussed. (B.G.D.)

14477 THE PHYSICAL MEASUREMENTS OF ELECTRON BEAMS FROM 6 TO 18 MeV: ABSORBED DOSE AND ENERGY CALIBRATION. Almond, Peter R. (Univ. of Texas, Houston). Phys. Med. Biol., 12: 13-24(Jan. 1967).

An aluminum calorimeter was used to measure the G-values for the ferrous sulfate dosimeter for incident electron energies of 13.25, 15.9, and 18 MeV. The ferrous sulfate dosimeter was then used to determine the correction factor to be applied to an ion chamber reading taken in a Lucite phantom to obtain absorbed dose in water. The factor was found to vary by 2% from 6 to 18 MeV, which can be correlated to the change in the average relative stopping power of the electrons in the phantom and the gas, taking the polarization effect into account. The absorbed dose calibration using the above method is accurate to within 2%. A quick and relatively accurate method was described for determining the energy of the electron beam. Agreement within 3% was found between this method and the method utilizing the measured electron range. (auth)

14478 THERMO-VOLTAIC RADIATION DOSIMETRY. Toole, J. M.; Henisch, H. K.; Miyashita, K. (Pennsylvania State Univ., University Park). Nature, 213: 698-9(Feb. 18, 1967).

It has been found that thermoelectric properties can be used for dosimetric purposes. The principle is simple, although in practice complications arise. The incoming radiation would be expected to charge electron traps in proportion to dosage received. Subsequent heating of the material in the presence of a thermal gradient should then yield a temporary thermopower which is lower than that associated with unirradiated specimens because of the release of free carriers from the traps. Once these carriers have recombined, thermally or radiatively, the original value should be restored. Some studies with ZnS are described, employing u/v light and x-rays. Several probably related factors cause complications. Space charge regions arise from local variations in the population of the filled trap and from the contact parameters (opposite faces are not equivalent). The observed reversal of polarity is thought to be connected with these factors. Other materials which were studied include CdF_2, LiF, SrF_2, CaF_2, BeF_2. (UK)

14479 MUST PERSONNEL DOSIMETERS ALSO SERVE AS GAMMA RAY ENERGY SPECTROMETERS? Attix, F. H. (Naval Research Lab., Washington, D. C.). Health Phys., 13: 219-21 (Feb. 1967).

The energy dependence of photographic film has proved a considerable disadvantage. With the advent of the use of LiF (or other new materials) as an alternative, the question of the desirability of employing energy independent personnel dosimeters is being reexamined. Since the gamma ray exposure in roentgens depends directly on the energy absorption coefficient of air, an energy independent dosimeter is air-equivalent. What an ideal air-equivalent dosimeter, calibrated in roentgens, will indicate when worn on various parts of the body is discussed. The use of a combination of two dosimeters, having different degrees of energy dependence, such as CaF_2 and LiF thermoluminescence dosimeters, as a spectrometer is also discussed as well as a different approach based on the idea of tailoring the response/energy function of a dosimeter to imitate that of another system. (B.G.D.)

14480 TWIN DOSIMETER SET. Paul, I. R.; Septimus, N. (New York City Dept. of Health). Health Phys., 13: 221-3(Feb. 1967).

The instrumentation described is in connection with inspection of medical fluoroscopic installations. A low cost, rugged instrument was required, and an exposure meter, rather than an exposure rate meter, was preferred. It was decided that a pair of self-reading pocket dosimeters, one of which would be permanently banded with aluminum as a modification of the cap-on, cap-off method, would most nearly meet the needs of inspectors in the field. By modification of an existing pocket dosimeter a prototype self-reading instrument with a 150 to 200 mg/cm^2 polypropylene chamber wall, a range of 0 to 20 R, and a weight of 0.6 oz. was produced. The charger was a standard Bendix CDV-756, weighing 18 oz. Dosim-

eters were paired according to similarities of correction factors in relation to an Electronics Instruments Ltd. Model 37A electrometer. Methods for using the dosimeter system are described. The reading of the unshielded dosimeter represents the output of the fluoroscope at the panel. The ratio of readings of the two dosimeters represents the total equivalent aluminum filtration in the useful beam. The instruments satisfactorily met the requirement for energy independence, range, rugged construction, reliability, light weight, and cost. (UK)

14481 EFFECT OF DOSE ON THE ENERGY DEPENDENCE OF LiF THERMOLUMINESCENT RADIATION DOSIMETERS. Woodley, R. (Brookhaven National Lab., Upton, N. Y.). Radiat. Bot., 7: 1-5(Feb. 1967). (BNL-10077).

Lithium fluoride crystals used as thermoluminescent dosimeters show a clear energy dependence which is a function of the radiation dose. Dosimeters are more sensitive to low than to high energy radiation at low dose, of equal sensitivity at some intermediate dose range, and less sensitive at high dose. The prior annealing history of the crystals influences their absolute sensitivity and also their dose-dependence; this can be minimized by proper choice of annealment time and temperature. Thus, when LiF is used as a dosimeter for different energy radiations or in a radiation field consisting of high and low energy components, the influence of energy dependence and also of dose must be known and considered. (auth)

14482 FLUENCE-DOSE CONVERSION CURVES AND THEIR APPLICATION TO NEUTRON CALIBRATION TECHNIQUES WITH (α,n) SOURCES. Nachtigall, D. (EURATOM, Geel, Belg.). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-76/61, 10p. (CONF-660807-26). ORAU.

From Symposium on Neutron Monitoring for Radiological Protection, Vienna.

In the practical fast neutron calibration techniques there are three different dose-flux conversion procedures. The factor d_k converts the flux of monoenergetic neutrons to kerma in standard tissue, the factor d_m converts the flux of monoenergetic neutrons to maximum absorbed dose in a 30 cm slab of standard tissue, and the factor d_e converts the flux of monoenergetic neutrons to dose equivalent. The factor d_k as a function of neutron energy is given in NBS Handbook 85. The factors d_m and d_e can be obtained in two ways: d_k multiplied by a "build-up" factor as given by de Pangher and in NBS Handbook 63 yields d_m. d_m multiplied by the corresponding quality factor as given in NBS Handbook 75 yields d_e. By the help of "maximum permissible neutron flux" as given in the NBS Handbooks 63 and 75 one can obtain d_e. d_e divided by the corresponding quality factor yields d_m. The d_m- and d_e-values obtained in these ways and drawn as a function of neutron energy form the conversion curves. However, the two d_m-curves and the two d_e-curves are not congruent. The differences which arise when these different curves are applied in the calibration techniques with (α,n)-sources are reported. (auth)

14483 EFFECTS ON FERROUS SULFATE DOSIMETER SOLUTION STORED IN SMALL POLYSTYRENE CELLS. Svensson, H.; Pettersson, C.; Hettinger, G. (Univ. of Umea, Sweden). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-78/13, 16p. (CONF-661005-22). DTIE.

From Symposium on Solid-State and Chemical Radiation Dosimetry, Vienna.

In ferrous sulphate dosimetry plastic dosimeter cells are often used in order to get a tissue equivalent dosimeter. However, systematic investigations showed that storage in polystyrene dosimeter cells caused effects which do not appear with for instance quartz cells. At the photometric evaluation on one hand absorbance was observed in unirradiated dosimeters and on the other an increased optical response was observed in irradiated dosimeters which had been stored before irradiation. Furthermore the reproducibility of the dosimeter was affected by storage. (auth)

Radiometric Instruments

Refer also to abstract 14400.

14484 (N-66-37271) A THEORETICAL STUDY OF THE GAMMA-RAY SCATTERING TECHNIQUE FOR MEASURING ATMOSPHERIC DENSITY. Final Report. Gardner, R. P.; Whitaker, D. R. (Research Triangle Inst., Durham, N. C. Measurement and Controls Lab.). Aug. 1966. Contract NAS 1-5467. 58p. (NASA-CR-66142). CFSTI $3.00 cy, $0.65 mn.

A theoretical, mathematical modeling study of the gamma-ray scattering technique for measuring atmospheric density is described. A basic model was derived, which describes the response of this technique in a cylindrically symmetrical geometry like that used to date in prototype gages flown in Nike-Apache vehicles. Two other models were derived to describe the response of a gage of this type in a steel wall vacuum sphere and the response to gamma-ray streaming down the rocket walls. An existing Monte Carlo calculation was used to calculate shield effectiveness. The predicted gage response was linear with atmospheric density, independent of atmospheric composition if gamma-ray energies larger than 0.1 MeV are employed, effected by atmospheric density as far as 10 meters from the rocket, and independent of shock-wave density perturbations likely to be encountered. The sensitivity of the gage is at a maximum for air at a gamma-ray energy of 0.038 MeV and depends on the reciprocal of the source-to-detector distance. The significant problems identified are inaccurate calibration technique, a high background response due to gamma-ray streaming down the rocket wall, and a dependence on atmospheric composition if gamma-ray energies less than 0.1 MeV are used. (auth)

14485 (NP-tr-1477) THICKNESS-MEASURING DEVICE BASED ON RADIOACTIVE SOURCES FOR AUTOMATIC GAGING OF FILMS AND SHEETS DURING PRODUCTION. Loznovskii, Yu. Ya. Translation of Radioaktivnyi Tolshchinomer Dlya Avtomaticheskogo Kontrolya Tolshing Plenochnykh i Tistovykh Materialov v Protsesse Ikh Izgotovleniya. 19p. (TT-65-50134, IPST-Cat.- 1430). Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80 mf.

The radiation thickness gage is described which can be used for the noncontact continuous thickness measurement of materials of different chemical composition and density. By a suitable choice of radioisotopes and modification of the construction of the measuring unit it is possible to measure the thickness of various areas of different plastic and sheet materials. Using sources of a narrow rectangular shape one can measure the thickness of narrow strips of material. Using point-type radiation sources one can measure an area of several square millimeters. The radiation thickness gage is of simple construction, comparatively inexpensive to produce, and does not require skilled service personnel. The thickness gage, in use since August 1961 till the present, has proved that the electronic circuitry is reliable, and that the whole maintenance consists mainly of the timely replacement of electronic tubes. (auth)

14486 MEASUREMENT OF HUMIDITY BY THE SLOWING DOWN OF FAST NEUTRONS. Boirat, R. Ann. Radioelec., 22: 51-8(Jan. 1967). (In French).

Humidity is a very important parameter in many industrial processes. It has to be determined when preparing products with a specified degree of humidity, when mixing constituents in definite proportions, and it is the concern of very many industries. Foundry sand, concrete, ceramic materials are products of which the degree of humidity has to be adjusted at a constant value. The glass industry, agglomeration plant also need this factor. A method of measurement is described using the slowing down of fast neutrons which is particularly applicable to problems arising in modern industry. (tr-auth)

14487 RADIOACTIVE PROCEDURES FOR MEASUREMENT OF FILM THICKNESS. PART I. Kosbahn, Thomas (Arolsen, Kreis Waldeck, Ger.). Arch. Tech. Messen, No. 367, 169-74 (Aug. 1966).

The nature and characteristics of α radiations in terms of velocity, specific ionization, and energy are compared with mass density. The use of α radiation for density measurements is illustrated by a probe type instrument that uses an ionization chamber for measurement. Properties of β emitters, such as max energy, max range, and half value layers, are compared to indicate their use for thickness measurements. The nature of β radiation is reviewed, and their ranges and max energies are depicted graphically. Absorption curves are compared, and the mass absorption coefficient is plotted as a function of the max energy of several β emitters. Various mathematical relations are derived to indicate the suitability of β emitters for thickness measurements. (BBB)

14488 DETERMINATION OF ALUMINA FILM THICKNESS BY ALPHA PARTICLE SCATTERING. Peisach, Max; Poole, Darrell O.; Roehm, Hermann F. (Southern Universities Nuclear Inst., Faure, Africa). Talanta, 14: 187-94(Feb. 1967).

The scattering of accelerated alpha particles was used to determine the surface oxide film thickness of anodized aluminum. The measurements were based on determining the difference between the energy of an alpha particle scattered from the surface oxide layer and that from the underlying metal. Films ranging in thickness from 10 to 130 $\mu g/cm^2$ were analyzed nondestructively with a relative standard deviation of 3.5%. The average time for an analysis was 30 min with an incident beam current of up to about 1 μA. (auth)

14489 DETERMINATION OF THE THICKNESS OF THIN LAYERS. Schaerf, K.; Vuorinen, A. (International Atomic

Energy Agency, Vienna). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/62, 16p. (CONF-661012-43). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

When radioactive sources are counted on an absolute basis the sources are often mounted on thin uncoated or coated films. Usually the experimenter needs to know the thickness both of the film and of the coating. An alpha particle thickness gauge is described where the energy loss of ^{241}Am α-particles in films is used as a measure of the thickness. Measurements are made under vacuum and the α's are detected by a surface barrier detector. This system is applicable for film thicknesses from a few $\mu g/cm^2$ up to some mg/cm^2. For foils up to 200 $\mu g/cm^2$, the accuracy is ± 1 $\mu g/cm^2$. The calibration is done by weighing. Some experiments are also described where film (VYNS) thickness and the thickness of evaporated metal (Au) coating on it was determined by the x-ray fluorescence method. Experiments were checked by weighing and by activation analysis. Results showed that this method is applicable within a range of 1 to 100 $\mu g/cm^2$. (auth)

Miscellaneous Instruments and Components

Refer also to abstracts 14418, 14929, and 15526.

14490 (BNWL-SA-390) INSTRUMENTATION IN BIOLOGY. Porter, N. S. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 9, 1965. Contract AT(45-1)-1830. 23p. (CONF-651127-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From IEEE Technical Meeting, Student Chapter, Pullman, Wash.

Some of the activities in the categories of bionics, medical instrumentation in space, and medical electronics as conducted throughout industry are reviewed. A brief review of the biological instrumentation developed at Hanford is also presented. (B.G.D.)

14491 (CONF-660221-, pp 321-5) SPLIT POLE MAGNETIC SPECTROGRAPH. Viswesvariah, M. N.; Sarma, N. (Atomic Energy Establishment, Trombay (India)).

The theory of a split-pole magnetic spectrograph is briefly outlined. (B.G.D.)

14492 (CONF-660221-, pp 345-7) PICK-UP REJECTION SCHEME FOR LOW COUNTING RATE EXPERIMENTS. Mehta, G. K. (Indian Inst. of Tech., Kanpur); Melkonian, E. (Columbia Univ., New York).

In a low counting rate experiment, as the detector of ternary alphas in fission, spurious pulses arising from electrical pick-up, transients, etc., produce a significant background and introduces a large uncertainty in the analysis. A circuit was designed to reject these pulses with repetition rate less than 3 μsec and pass through the pulses coming in at intervals greater than 3 μsec as genuine pulses. (B.G.D.)

14493 (CONF-660221-, pp 348-50) TWO PARAMETER ANALYZING FACILITY FOR COINCIDENCE EXPERIMENTS IN NUCLEAR REACTIONS. Ragoovansi, N. L.; Mitra, P. C.; Eswaran, M. A. (Atomic Energy Establishment, Trombay (India)).

For use in coincidence experiments in nuclear reactions involving simultaneous pulse height analysis of spectra from two radiation detectors, a system was built which extends the utility of the TMC 400 channel pulse height analyzer to that of a two parameter analyzer by making use of a 20 channel Gatti type pulse-height analyzer. This is facilitated by incorporating fast-slow coincidence systems. (B.G.D.)

14494 (CONF-660221-, pp 351-5) ON SMALL SIGNAL NON-LINEARITIES IN FIXED PROGRAMME PROCESSORS. Patwardhan, P. K.; Phadnis, M. G.; Chatur, C. G.; Talgeri, G. S. (Atomic Energy Establishment, Trombay (India)).

The utilization of analog to digital converters in modern pulse amplitude analyzers is an accepted practice. In Wilkinson type ADC's small-signal nonlinearity produces lack of precision and a non-zero intercept in calibration plots. This is more predominant in 10 to 20 channel analyzers with a presorter where this occurs at every step. In transistorized analyzer the predistal technique is used to minimize this effect. An adaptation of this technique for large signal vacuum tube logic is presented. (B.G.D.)

14495 (CONF-660221-, pp 356-9) MULTICHANNEL ANALYSER DATA PROCESSING BY CDC-3600. Lamba, C. M.; Sarma, N. (Atomic Energy Establishment, Trombay (India)).

A method of using the computers CDC-160A and CDC-3600 to analyze data from a 400 channel analyzer used in measurement of excitation functions with a Van de Graaff accelerator is described. (B.G.D.)

14496 (DP-1079) SOLID-STATE PLUG-IN CIRCUITS AS INSTRUMENT BUILDING BLOCKS. Woodward, W. J. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Jan. 1967. Contract AT(07-2)-1. 16p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Seven standard solid-state circuits were developed for use in radiation instrumentation. These circuits are a pulse amplifier, a variable discriminator, a pulse-shaping univibrator, a counting tube (dekatron) driver, a count rate meter, and multiple range and time constant circuits to operate with the count rate meter These circuits may be combined to make instruments for specific needs. (auth)

14497 (N-67-10894) THE THEORETICAL AND EXPERIMENTAL DETERMINATION OF THE INPUT IMPEDANCE OF A SMALL LOOP OF ELECTRIC CURRENT IMMERSED IN AN ANISOTROPIC PLASMA. Duff, G. L.; Mittra, R. (Illinois Univ., Urbana. Dept. of Electrical Engineering). Oct. 1966. 122p. (NASA-CR-79711; SR-8). CFSTI $3.00 cy, $0.65 mn.

The loop impedance is calculated by two methods of approximation for the case where the imposed steady magnetic field is normal to the plane of the loop. The first method uses the quasi-static approximation, for which a first order correction term is also calculated. The second approximate method involves the assumption that the medium is uniaxial. The loop impedance is also calculated under the uniaxial approximation for the case where the imposed steady magnetic field is parallel to the loop. A discussion of the experimental techniques in measuring the loop impedance is given. A brush-cathode discharge chamber was used. The theoretically derived impedance formulas are numerically evaluated for a wide range of the plasma parameters and the measured loop impedance is compared to the theory. There is good general agreement between the theoretical and measured loop impedance. (auth)

14498 (NP-16546) ETUDE DES PROPRIETES STATISTIQUES DE LA STRUCTURE MULTIPLICATRICE D'UN PHOTOMULTIPLICATEUR. (Studies of the Statistical Properties of the Multiplier Structure of a Photomultiplier). Bouche, Richard (Lyon Univ. (France). Faculte des Sciences). Feb. 24, 1965. 87p. (In French). Dep. mn.

Thesis.

After a review of the studies made on various resolutions for photomultipliers, the calculation of the time resolution is attempted by making an approach to a statistical study of the photomultiplier. The energy resolution is first calculated. For the time resolution an analysis of the action of different parts of the photomultiplier with respect to the time variable shows that it is impossible to use classical procedures. Therefore it is proposed to use the Monte Carlo method to calculate the percussional response of the photomultiplier. This consists of computer simulation of the operation of the photomultiplier. This method of calculation is described and it is shown how it is possible to generate statistical distributions in a computer and how such generations make it possible to simulate random phenomena. An attempt is then made to define a statistical model of the photomultiplier beginning with known experimental results making it possible to define the simulation programs. Two simulation procedures are then studied: a very simple model of the photomultiplier and a more realistic model of the photomultiplier. The results show that the study is much more profitable in the case of a simple multiplying structure than in the case of the complex model. (J.S.R.)

14499 (ORNL-TM-1743) VACUUM PYCNOMETER USING MERCURY WITH PLUNGER DISPLACEMENT FOR HOT CELL USE. Dismuke, S. E.; Stone, R. L. (Oak Ridge National Lab., Tenn.). Feb. 1967. Contract W-7405-eng-26. 17p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An instrument was developed to measure the bulk volume as a step in obtaining the bulk density of porous fuel pellets in a master slave manipulator equipped hot cell. The volume that is actually measured is estimated as that volume bound by the exposed surface of the sample and the area over cracks and pores less than 14 microns wide. Accuracy of this instrument is ± 0.0003 cm^3 which is better than accuracy got with submersion weighing of nonporous samples with standard equipment in the hot cells. Volumes of 0.16 cm^3 are measured directly. Measurement time was 40 min per sample. The basic design and important construction details are given with a detailed discussion of the various factors that reduce the ultimate accuracy. Operating procedures and a procedure for filling the pycnometer with mercury are also covered in detail. (auth)

14500 (RISO-M-501) BERETNING OM ARBEJDET I ELEKTRONIKAFDELINGEN I TIDEN 1 JULI TIL 30 SEPTEMBER

1966. (Quarterly Report of the Electronics Department for the Period July 1–September 30, 1966). (Danish Atomic Energy Commission, Risoe. Research Establishment). Nov. 1966. 23p. (In Danish and English). (R–10–66). Dep. mn.

Instrumentation of reactor irradiation experiments using an on-line computer (PDP-8) are discussed. Topics include data transmission from neutron spectrometers, interface equipment between analog systems and digital computers, analog model of human blood circuit dynamics, and β and γ detector electronics. (Denmark)

14501 (UCRL-Trans–10081) STUDIES ON THE CALORIMETRIC MEASUREMENT OF RADIATION. PART I. ENERGY FLUX OF 100-300 kVp X-RAYS. Inada, T.; Kawashima, K.; Takaku, Y.; Hoshino, K.; Matsuzawa, H. Translated for Univ. of California Lawrence Radiation Lab., Livermore, from Nippon Igaku Hoshasen Gakkai Zasshi, 21: 197-202(1961). 30p. Dep. mn. JCL $2.60 fs, $1.10 mf.

A method on the calorimetric determination of x-ray energy flux from 100 to 300 kVp is described with some results. This method gives an absolute unit measurement. Therefore it seems to be more reasonable to estimate the effective energy of x rays from the energy flux (Ef), because there are doubtful points in the effective energy determination based on the half-value layer. The corrected relation between them is shown. Then, the attenuation of x-ray intensity through muscle equivalent material is discussed. In nonfiltered x-ray range, Ef changes with material thickness, but in medium filtered or more hard range, such a change is not found. (auth)

14502 SOME PROBLEMS CONCERNING THE THEORY OF ERRORS OF PULSE COUNTERS. Rzymkowski, Tadeusz; Trechcinski, Roman (Inst. of Nuclear Research, Warsaw). Nukleonika, 11: 811-19(1966). (In Polish).

The principal errors in counting systems are defined and relations as well as some mathematical derivations for practical use in the determination of the errors of measurements are given. The method allows a rational design of counting systems in regard to the system's quality as well as economy of technical solution. (auth)

14503 X-Y DISPLACEMENT TRANSDUCER. Angelino, G. (CISE, Milan). Energ. Nucl. (Milan), 14: 107-8(Feb. 1967).

An instrument was developed which allows displacement measurements as low as a few tenths of a millimeter with a 1% full scale accuracy; higher ranges can be obtained by changing the length of the external connecting arm. (B.G.D.)

14504 LINEAR BIASED GATE. Manfredi, P. F.; Maranesi, P.; Rimini, A. (Politecnico, Milan). Energ. Nucl. (Milan), 14: 95-8(Feb. 1967).

A biased gate making use of a diode in an operational feedback loop is described. It may accomplish both the functions of the opening in correspondence of a gating pulse and of the subtraction of a variable lower portion of the input pulse. This circuit is characterized by a very high transmission linearity and low pedestal. (auth)

14505 SEMI-AUTOMATIC MONOCHROMATOR FOR THE DETERMINATION OF EXCITATION CROSS SECTIONS. Schutten, J.; van Deenen, P. J.; de Haas, E.; de Heer, F. J. (Stichting voor Fundamenteel Onderzoek der Materie, Amsterdam). J. Sci. Instrum., 44: 153-5(Feb. 1967).

A semi-automatic grating monochromator was developed by modifying and extending a commercially available Leiss monochromator. The prism was replaced by a grating and the following elements were added: a photomultiplier with Peltier cooling, an electric drive for the wavelength setting, a moving slit mechanism for the measurement of the intensity of a spectral line superimposed on a continuous background signal, and a polarizer. The instrument can be operated manually, remotely controlled or programmed by a stepping switch. In this way a series of measurements can be performed automatically; the results are punched out on tape. The instrument is being used for the determination of atomic spectral lines in the case of electron impact on atomic and molecular gases in the energy region 0.05–20 keV. (UK)

14506 REDUCTION OF NOISE AND DARK CURRENT IN PHOTOMULTIPLIER TUBES BY MAGNETIC DEFOCUSING. Frommhold, L.; Feibelman, W. A. (Univ. of Pittsburgh). J. Sci. Instrum., 44: 182-3(Feb. 1967).

Measurements of dark current and the associated noise were made for cooled and magnetically controlled photomultiplier tubes (S-20 cathodes). With restricted areas of incident light, a reduction of almost one order of magnitude was obtained in dark current by using the magnetic field, in addition to that produced by cooling. The noise was correspondingly reduced, and the signal sensitivity was maintained. (UK)

14507 BETATRON MEGAVOLTMETER. Gorbunov, V. I.; Grigor'ev, A. P. Izmeritel. Tekh., No. 1, 94-5(Jan. 1967). (In Russian).

The γ radiation energy of a betatron was determined by measuring the voltage amplitude at the moment of extraction. The design and operation of a megavoltmeter for this purpose are described. (R.V.J.)

14508 ANALYSIS OF THE NEGATIVE CHARACTERISTIC OF A CYLINDRICAL PROBE IN A MAGNETIC FIELD. Dote, Toshihiko; Amemiya, Hiroshi (Inst. of Physical and Chemical Research, Tokyo). J. Phys. Soc. Jap., 22: 270-6(Jan. 1967).

An analysis is made of the characteristics of a cylindrical probe in a magnetic field, for the voltage region above the plasma space potential. It is assumed in the analysis that the plasma and the sheath are completely separated. The equation for the probe current is numerically solved in a dimensionless form for several values of $\alpha\xi_\rho$ with the sheath thickness as a parameter, where α and ξ_ρ are the normalized magnetic field and the probe radius, respectively. The probe characteristics are obtained by eliminating the sheath thickness from the probe equation, and the space-charge-limited current in a magnetic field between coaxial cylinders is calculated under the condition that electrons leave the outside cylinder without initial velocity. The negative characteristic is shown to appear when $\alpha \geq 0.5$ and $\alpha \geq 0.8$, where $\alpha = A\xi_\rho/2\sqrt{2}$. (auth)

14509 SYRINGE FOR INJECTING SODIUM–POTASSIUM ALLOY. Greenhalgh, Samuel (Univ. of Pennsylvania, Philadelphia). Rev. Sci. Instrum., 38: 121-2(Jan. 1967).

For MHD power generation and propulsion there is a need for an effective way of seeding the plasma with alkali metal. A syringe injection system has been developed for this purpose. The injection system is briefly described. (M.O.W.)

14510 LIGHTWEIGHT 50 kG SUPERCONDUCTING MAGNET SYSTEM FOR OPTICAL RESEARCH INSTRUMENTATION. Hawkins, S. R.; Harshman, J. H. (Lockheed Palo Alto Research Lab., Calif.). Rev. Sci. Instrum., 38: 50-2(Jan. 1967).

Since the discovery of high field superconductors, it has been possible to generate high magnetic fields with lightweight, compact superconducting solenoids. In most cases, these magnets are operated in conventional liquid helium Dewars which are heavy and unwieldy and usually offer only vertical access to the magnetic field, which makes them very inconvenient for many uses, such as with optical research instrumentation. A system is described in which the magnet and cryostat are integrated into a single light weight package which weighs only 13.6 kg and provides horizontal access to magnetic fields in excess of 50 kG with working bores of 3.80 cm at temperatures near 4.2°K and 2.54 cm at room temperature for periods up to 12 h between fillings. Due to its over-all configuration, the magnetic field is highly accessible and allows spectroscopic measurements to be made conveniently at 50 kG. Also, the system can be easily transported while it is filled with liquid helium. (auth)

14511 APPARATUS FOR MICROWAVE MEASUREMENT OF TRANSPORT PARAMETERS IN SEMICONDUCTORS. Brodwin, M. E.; Parsons, M. K. (Northwestern Univ., Evanston, Ill.). Rev. Sci. Instrum., 38: 79-84(Jan. 1967).

The essential component of the apparatus is a semiconductor loaded E plane T waveguide junction. The scattered wave produced by the induced anisotropy is measured. The principal result is that the apparatus directly determines the complex amplitude of the off-diagonal element of the apparent susceptibility. The technique can be used to measure effective mass at higher temperatures than is possible with the cyclotron resonance absorption cavity technique. It can also be employed to determine the mobility of powdered or irregular samples. (auth)

14512 ELECTRON MONOCHROMATOR DESIGN. Kuyatt, C. E.; Simpson, J. Arol (National Bureau of Standards, Washington, D. C.). Rev. Sci. Instrum., 38: 103-11(Jan. 1967).

A study was made of all the known factors which limit the performance of high resolution (0.07 to 0.01 eV FWHM) monochromators. These limiting factors were incorporated into design equations for the optimum (maximum current output) monochromator. The conclusions are tested by performance measurements on a prototype instrument. The results require the introduction into the design equation of a new limiting factor, an anomalous energy spread in dense electron beams, which is empirically determined. (auth)

14513 SHUNT FOR PULSED CURRENT EXPERIMENTS ON SUPERCONDUCTING WIRES. Schmitz, J. A. (Frankford Arsenal, Philadelphia). Rev. Sci. Instrum., 38: 132-3(Jan. 1967).

The use of pulsed currents to study the superconducting to normal (S–N) transition in short wire samples is discussed. In

using pulsed currents the moment normal resistivity appears, heat is generated and, unless the rapidly increasing current can be withdrawn from the sample, deformation or total destruction can result. A shunt circuit using a type 1N3169 diode is described for overcoming this difficulty. (B.G.D.)

14514 DIFFRACTION CAMERA FOR PRECISION MEASUREMENT OF LATTICE PARAMETERS AT LOW TEMPERATURES. Mascarenhas, Y.; Mascarenhas, S. (Univ., Sao Paulo, Brazil). Rev. Sci. Instrum., 38: 141-2(Jan. 1967).

A low temperature modification of the parafocusing symmetrical Seeman–Bohlan x-ray diffraction camera which extends its useful range to liquid nitrogen temperatures is described. (B.G.D.)

14515 CURRENT INTEGRATOR (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1544).

4 drawings.

The solid-state direct current integrator may be used for currents as low as 10^{-11}A with an accuracy of 1%. Voltage across a storage capacitor in the input circuit is monitored by an electrometer type operational amplifier, the output of which triggers a discriminator at a given voltage level. The discriminator generates a reset pulse which removes a fixed charge from the integrating capacitor. Silicon planar transistors operate in the inverted-mode and serve as current switches. Reset pulses switch the transistors from the reverse-biased state to the active state for a precise time during which a constant current flows to or from the integrating capacitor. Each reset pulse removes from the integrating capacitor a precise charge that is the product of the current and the period of the active state. By employing a sufficient gain in the operational amplifier to maintain small voltage excursions at the input, total effective leakage may be kept as low as 10^{-14}A. A scaler output provides an indication of the integrated charge. A built-in duty cycle meter calibrated in counts per second provides an indication of instantaneous current. The integrator may be used in 5¼ in. and 8¾ in. standard bins. (For details see TID-4100 Suppl. 39) (F.S.)

14516 ACCURATE MEASUREMENTS OF DROP WEIGHTS BY THE EXTRAPOLATION METHOD. Oakley, A. E.; Lowenthal, G. C. (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/42, 16p. (CONF-661012-39). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

Of the two methods currently employed by standardizing laboratories for the weighing of drops of active solutions, the extrapolation method is known to be prone to errors. However, it is very convenient to store active solutions in rubber-capped vials and to use disposable syringes for extraction and deposition; but this requires the use of the extrapolation technique for weighing. Studies were made with the aim of attaining accuracies for the extrapolation method not less than the ±10 μg attainable with the pycnometer method. The following procedures were adopted: The weighings of the drop mass were started at the earliest possible moment. For a microbalance such as the Mettler M5, weighings can generally be started 20 seconds after deposition for drop weights below about 15 mg and within 30 seconds after deposition for drop weights up to 100 mg. Evaporation losses were reduced by maintaining the balance at relative humidities up to 95%. Normal ambient relative humidities in Sydney range from about 35% to 75% depending on the season. The temperature of the active solution in the syringe was depressed to the expected equilibrium temperature of the deposited drop. This was done by enclosing the glass needle attached to the syringe with a woven nylon sleeve saturated with the appropriate mixture of water and glycerol. Detailed methods are presented and some aspects of the evaporation process for water and hydrochloric acid are discussed. (auth)

14517 WIDE RANGE 50 psec RESOLUTION DIGITAL TIME SORTER. Cottini, C. (Laboratori CISE, Milan); De Lotto, I.; Dotti, D.; Gatti, E.; Vaghi, F. 26p. (CONF-660918-14). DTIE. Gmelin, AED-CONF-66-285-2.

From International Conference on Instrumentation for High Energy Physics, Stanford, Calif.

A digital time sorter was developed with a time interval range practically unlimited and with a time resolution fitted to actual radiation detection system performances and to the next expected progresses (50 psec minimum channel width). (B.G.D.)

Radiation Effects on Instruments and Instrument Components

Refer also to abstracts 14472 and 14923.

14518 (N-66-39899) THE RELAY I RADIATION EFFECTS EXPERIMENT. Waddel, Ramond C. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Nov. 1966. 23p. (NASA-TN-3665; NASA-SP-76). CFSTI $3.00 cy, $0.65 mn.

Solar cells on Relay I were monitored for radiation damage by measurement of short circuit current. The orbit was 1321 km perigee, 7439 km apogee, 47.5 degrees inclination. Unshielded N/P, P/N, and gallium arsenide cells degraded in 10 days to 52, 28, and 18 percent, respectively. This damage is ascribed to low energy protons. At 300 days, silicon N/P and P/N cells, shielded with 30 mils of fused silica, had degraded to 73 and 53 percent respectively. At 300 days, silicon N/P and P/N cells, shielded with 60 mils of fused silica, had degraded to 80 and 61 percent, respectively. Available space flux maps predicted somewhat greater damage to the heavily shielded cells, from either electrons or high energy protons, than that observed. The minority carrier lifetime of some 1N645 silicon diodes declined to 50 percent in about 45 days. (auth)

14519 (N-66-39985) EXPERIMENTAL STUDY OF EFFECTS OF ELECTRON IRRADIATION FROM 20 keV TO 1 MeV ON A POLYETHYLENE, TEREPHTHALATE CAPACITOR-TYPE METEOROID DETECTOR. James, Thomas G.; Heyson, Harry H.; Frank, Clifford S. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). Nov. 1966. 29p. (NASA-TN-D-3682). CFSTI $3.00 cy, $0.65 mn.

A capacitor-type meteoroid detector was irradiated with low-energy electrons. Under irradiation, this detector produced pulses that were counted in a satellite-type detection circuit. At liquid-nitrogen temperature, the number battery voltage (over a range from 0 to 135 V) and the electron dose rate (over a range from 3.1×10^7 e/cm^2-sec to 3.1×10^{10} e/cm^2-sec) are given. The greatest number of pulses was observed at liquid-nitrogen temperature (77°K). The number of pulses decreased with increasing temperature; however, radioinduced pulses still occurred at temperatures on the order of 363°K. It is believed that the pulses were caused by electron charge storage and subsequent discharge within the polyethylene terephthalate dielectric of the detector. The results of a few preliminary tests of a coincidence-type detector, designed to discriminate against radiation pulses, are also presented. (auth)

14520 (SC-DC-66-2443) SEMICONDUCTOR DEVICE AND CIRCUIT TRANSIENT RESPONSE CAUSED BY IONIZING RADIATION. Rogers, S. C. (Sandia Corp., Albuquerque, N. Mex.). Dec. 1966. Contract AT(29-1)-789. 30p. (CONF-670303-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Symposium on Radiation Effects in Semiconductor Components, Toulouse, France.

An investigation was made on semiconductor and circuit transient response caused by ionizing radiation. Transient responses of diodes and transistors are described qualitatively in terms of carrier generation and movement and quantitatively by theoretical models whose limitations are discussed. The practical aspects of predicting circuit response are considered and a comparison of predicted and measured response is made for a particular circuit. Finally, studies pertaining to the response of monolithic integrated circuits are discussed. (B.G.D.)

14521 PROTON IRRADIATION EFFECTS IN MOS AND JUNCTION FIELD-EFFECT TRANSISTORS AND INTEGRATED CIRCUITS. Bryant, Floyd R.; Fales, Carl L. Jr.; Breckenridge, Roger A. (Langley Research Center, Hampton, Va.). 32p. (CONF-661122-2). DTIE.

From 5th Annual Symposium on Failure in Electronics, Columbus, Ohio.

Because of the application of field-effect transistors, and integrated circuits in space electronic systems and the fact that proton irradiation data at energies typical of a space environment are not extensive, an experimental evaluation of these devices was conducted. The results obtained from the MOS field-effect study show that their degradation processes include that of charge storage in the silicon dioxide insulating layer and radiation-induced changes in surface states. MOS transistors were found to degrade at orders of magnitude less integrated proton flux than many bipolar and junction field-effect transitors; therefore, for space applications in radiation fields such as Van Allen Belts and solar particle events, these devices may be subject to serious radiation damage. The junction field-effect transistor displays a large initial spread in device irradiation response. However, it appears to possess a high degree of resistance to proton irradiation. The integrated circuits tested were of the monolithic type and under proton irradiation displayed a large reduction of minority carrier lifetime in the base region of the circuit transistors. Other less important defects are reduction of free carrier

concentration and reduction in mobility. Important electrical parameters that are affected by radiation are input threshold voltages, output low level voltages, leakage currents, and transient characteristics. In conclusion, MOS field-effect transistors and integrated circuits display significant damage characteristics when subjected to a space proton environment. It is important that these effects be considered when electronic circuits are to be subjected to a space radiation environment. (auth)

14522 SURFACE EFFECTS OF RADIATION ON MOS TRANSISTORS. Kuehne, B. M. (Hughes Aircraft Co., Fullerton, Calif.). 24p. (CONF-661122-3). DTIE.

From 5th Annual Symposium on Failure in Electronics, Columbus, Ohio.

Recent investigations have shown the metal-oxide-silicon field effect transistor (MOSFET) to be quite sensitive to radiation-induced surface effects. Experimental evidence toward identification of mechanisms responsible for device degradation is investigated. In particular, the time dependence of effects following both pulsed and steady-state irradiation was studied, since information is thereby provided on the type and concentration of radiation-dependent charge trapping states which affect device conductivity. Both intermediate and semipermanent conductivity changes following exposure to ionizing radiation were studied for three types of MOSFET's. These included n-channel enhancement, p-channel enhancement, and thin-film n-channel depletion units. Intermediate effects (referring to those whose time constants are typically 50 to 500 milliseconds following a radiation pulse of the order of 1 microsecond pulse width) were studied by means of observing drain current changes as a function of successive irradiations at various bias points. Both drain current changes and changes in transconductance were observed in the study of semipermanent effects resulting from each irradiation. One-half the number of samples of each type was irradiated with 10 MeV electrons, the remaining samples with equivalent dose ^{60}Co gamma rays. Significant long term effects were exhibited by all devices studied. Results for electron and ^{60}Co irradiation were in good agreement, indicating dependence on total absorbed dose, rather than dose rate, for semipermanent effects. The total absorbed dose for each device studied was of the order of 10^5 rads, an order of magnitude less than the accepted threshold for bulk damage in silicon. (B.G.D.)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 14275, 14597, 14673, 14706, 14710, and 14781.

14523 (BNWL-280) PACIFIC NORTHWEST LABORATORY ANNUAL REPORT FOR 1965 IN THE BIOLOGICAL SCIENCES. Thompson, R. C.; Swezea, E. G. (eds.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1966. Contract AT(45-1)-1830. 150p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Separate abstracts were prepared on 58 sections of this report. A list is included of publications during 1965. (C.H.)

For abstracts of individual sections see: 14312, 14524–14561, 14612–14616, 14633, 14634, 14673, 14706–14713, 14772, 15815, and 15816.

14524 (BNWL-280, pp 85-6) REMOVAL OF THYROID-BOUND IODINE. Dilley, J. V. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Thiazolidine-4-carboxylic acid was effective in removing thyroid-bound ^{131}I in rats. The most effective dose was well below the acute LD_{50} giving it an excellent chemotherapeutic index of over five. (auth)

14525 (BNWL-280, pp 74-6) EFFECT OF RADIATION ON LUNG TISSUE. Tombropoulos, E. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In thoracic x irradiated rats the lung collagen content increased between the second and fourteenth day postexposure, lung elastin was elevated between the tenth and twenty-fourth day, and total lung lipids were elevated between the eighth and eighteenth day. (auth)

14526 (BNWL-280, pp 18-19) HEPATOCARCINOGENS AND RADIONUCLIDE METABOLISM. Mahlum, D. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Dietary administration of certain hepatocarcinogens to rats altered the metabolism of injected ^{144}Ce, ^{239}Pu, and ^{59}Fe. The changes produced varied with carcinogen and radionuclide used. (auth)

14527 (BNWL-280, pp 59-62) RUTHENIUM OXIDE INHALATION STUDIES. Stuart, B. O. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Beagle dogs showed 50 to 80% pulmonary retention of inhaled submicronic $^{106}Ru-^{106}RhO_2$ up to 1 year after exposure. At 7 months postexposure 98% of the total body burden was in the lungs. Excretion of $^{106}Ru-^{106}Rh$ was predominantly by the fecal route. (auth)

14528 (BNWL-280, pp 34-5) AGE DEPENDENCE OF RADIOIODINE RETENTION IN RATS. Sikov, M. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Rats, from prenatal through 1 year postnatal, were injected with ^{131}I and sacrificed at intervals thereafter to obtain comparison of retention and distribution as a function of age and iodine content of the diet. Although the data have not been completely evaluated, it is clear that significant age differences will be defined. (auth)

14529 (BNWL-280, pp 62-4) CLEARANCE OF INHALED FERRIC OXIDE IN IRRADIATED RATS. Dilley, J. V. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Exposure of rats to 300 R whole-body x irradiation had no effect on the lung clearance of inhaled $^{59}Fe_2O_3$ particles up to 25 days after the inhalation exposure. (auth)

14530 (BNWL-280, pp 56-9) PROMETHIUM OXIDE INHALATION STUDIES. Stuart, B. O. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Beagle dogs were exposed to submicron size aerosols of promethium oxide labeled with $^{147+148m}Pm$. About half of the material initially deposited in the lungs was lost during the first week; that remaining was retained tenaciously with some evidence of translocation from the thoracic to abdominal regions. (auth)

14531 (BNWL-280, pp 65-6) REMOVAL OF INHALED RADIOACTIVE PARTICLES. Willard, D. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Of several agents administered as aerosols none were effective in removing inhaled $^{106}RuO_2$ from the lungs of rats. (auth)

14532 (BNWL-280, pp 64-5) EFFECT OF PHARMACOLOGICAL AGENTS ON INHALED PARTICLES. Dilley, J. V. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Treatment of rats with atropine sulfate prior to inhalation of $^{59}Fe_2O_3$ particles slightly decreased the quantity of material deposited in the lung. Treatment with 2,4-dinitrophenol had little, if any, effect on deposition of the inhaled particles. (auth)

14533 (BNWL-280, pp 53-5) STRONTIUM INHALATION STUDIES. Willard, D. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Rats were exposed to aerosols of ^{85}Sr-labeled strontium oxide, fluoride, carbonate, titanate, or phosphate. Only the titanate was significantly retained in the lungs over a 2-week period. From 80 to 90% of the body burdens of the other ^{85}Sr compounds rapidly accumulated in the skeleton. (auth)

14534 (BNWL-280, pp 49-52) LARGE PARTICLE INHALATION STUDIES. Stuart, B. O. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Ten and 26 μ, ^{59}Fe-labeled ceramic microspheres were deposited by inhalation in the lungs of beagle dogs. From 50 to 70% of the ^{59}Fe was excreted during the first 4 days after exposure, almost exclusively in feces. There was little clearance of the remaining material during the ensuing 2 months. (auth)

14535 (BNWL-280, pp 47-9) TAURINE EXCRETION FOLLOWING PLUTONIUM OXIDE INHALATION. Dilley, J. V. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

A decrease in circulating lymphocytes is usually correlated with an increased excretion of taurine in the urine of beagle dogs exposed to aerosols of $^{239}PuO_2$. Preliminary studies suggest that the increased level of urinary taurine originates from, and reflects the destruction of, circulating lymphocytes. (auth)

14536 (BNWL-280, pp 45-7) CHRONIC EFFECTS OF INHALED PLUTONIUM DIOXIDE IN DOGS. Park, J. F.; Bair, W. J.; Clarke, W. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Of 40 dogs exposed to $^{239}PuO_2$ aerosols, 13 died after 29 to 66 months. The body burden at death ranged from 0.5 to 3 μCi with 40 to 75% of the body burden in the lungs, 20 to 50% in the bronchial and mediastinal lymph nodes, 2 to 21% in liver, and 1 to 7% in skeleton. Cause of death was pulmonary insufficiency resulting from the severe pulmonary fibrosis. Seven animals showed bronchiolo-alveolar carcinomas. (auth)

14537 (BNWL-280, pp 2-4) SODIUM AND WATER TRANSPORT IN THE IRRADIATED INTESTINE. Sullivan, M. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In vivo perfusion studies show that water and sodium absorption from the small and large intestine of the rat are decreased to about half normal values three days after exposure to 1500 R x radiation. Movement of these constituents from blood stream to intestinal lumen is similarly depressed in the small bowel but not in the large intestine. Decreased absorption is the principal factor responsible for excessive fluid and electrolyte losses associated with the intestinal radiation syndrome. (auth)

14538 (BNWL-280, pp 4-8) TRANSPORT AND POTENTIAL MEASUREMENTS IN ISOLATED RAT INTESTINE. McKenney, J. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Sodium, potassium, chloride, cesium, and water transport in the intestine of young rats were studied. Results obtained suggested that there was active chloride absorption and potassium secretion by the ileum. Cesium transport and accumulation resembled that of potassium. Preliminary results demonstrated deleterious effects of x irradiation on the bioelectric and transport characteristics of the ileum. (auth)

14539 (BNWL-280, pp 28-31) STRONTIUM AND CALCIUM EXCRETION IN THE RAT. Hackett, Patricia L.; Thompson, R. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Following the intraperitoneal injection of ^{45}Ca and ^{85}Sr to mature rats on a high calcium diet, the ratio of urinary/fecal excretion of both radionuclides decreased with time postinjection. This effect was shown to be due to an increase in excretory clearance via the intestine. (auth)

14540 (BNWL-280, pp 31-2) RADIOSELENIUM STUDIES IN SHEEP. Watson, C. R.; Ragan, H. A.; McClanahan, Beatrice J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Selenious acid, labeled with ^{75}Se, in water or oil suspension was

subcutaneously injected into sheep fed either high or low selenium rations. The high selenium ration favored early rapid elimination. Injection as an oil suspension doubled the retention half-time of the long-term component. (auth)

14541 (BNWL-280, pp 35-7) NEPTUNIUM TOXICITY AND PLASMA LIPIDS IN THE RAT. Mahlum, D. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Neptunium-237 increased plasma free fatty acids in female but not in male rats. Cholesterol levels were decreased and Triton-induced hypertriglyceridemia was inhibited in both sexes by prior ^{237}Np treatment. (auth)

14542 (BNWL-280, pp 40-3) INGESTION OF PLUTONIUM OXIDE PARTICLES BY SWINE. Smith, V. H.; Palotay, J. L.; Ragan, H. A.; McClanahan, Beatrice J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The absorption in swine of ingested particulate, refractory $^{238}PuO_2$ is less than 10^{-6} of the dose. No gross pathologic changes were noted from 1 Ci of $^{238}PuO_2$ except in one pig where particles became entrapped in the intestinal wall. Passage time for this material was as long as 14 days. (auth)

14543 (BNWL-280, pp 66-70) EFFECT OF CIGARETTE SMOKING ON FATE OF INHALED PARTICLES. Bair, W. J.; Dilley, J. V. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The possible effects of chronic cigarette smoking on the clearance of particles from the lung were examined in beagle dogs smoking 20 cigarettes per day. Deposition and clearance of inhaled insoluble particles were tested periodically by exposing the dogs to aerosols of $^{59}Fe_2O_3$ or $^{51}Cr_2O_3$. No effects were seen in dogs after smoking cigarettes 5 days each week for over a year. (auth)

14544 (BNWL-280, pp 70-2) EFFECT OF CYANIDE ON CLEARANCE OF INHALED PARTICLES. Dilley, J. V. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Cyanide, a potent ciliostatic agent and a principal component of the gaseous phase of cigarette smoke, had little effect on the early clearance of inhaled $^{59}Fe_2O_3$ particles from rat lungs. It significantly inhibited clearance over a 25-day period. (auth)

14545 (BNWL-280, pp 72-4) EFFECT OF CYANIDE ON LIVER ENZYME ACTIVITY. Dilley, J. V. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The daily ingestion of cyanide by mice for a period of 4 months depressed liver catalase activity by 35 to 40%. The major cyanide detoxifying enzyme, transsulfurase, was only slightly inhibited but was apparently changed in its tertiary structure as indicated by its increased lability to heat and 4M urea solutions. (auth)

14546 (BNWL-280, pp 76-8) LUNG MITOCHONDRIA SYSTEM FOR FATTY ACID SYNTHESIS. Tombropoulos, E. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The mitochondrial fraction from dog lung was shown to be the most active subcellular fraction for fatty acid synthesis. The reduction of nucleotides could be a rate-limiting step in this synthesis. Cofactor requirements, stimulators, and the distribution of ^{14}C from ^{14}C-acetate within the product fatty acid indicate that fatty acid synthesis in rat lung mitochondria proceeds by elongation of preexisting shorter chain fatty acids. (auth)

14547 (BNWL-280, pp 88-91) THE EFFECT OF METHIONINE ON SYNTHESIS OF RIBONUCLEIC ACID IN ESCHERICHIA COLI. Matchett, W. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The relative rate of RNA synthesis by Escherichia coli is increased upon addition of methionine to a minimal medium. The effect is not confined to a single class of RNA. The relative rate of methylation of RNA is high in cells recovering from chloramphenicol poisoning, intermediate in cells grown in minimal medium and low in cells grown in medium containing methionine. Methionine enhances the rate of conversion of chloramphenicol ribonucleoprotein particles to 70 S ribosomes. From these findings, we infer that methionine increases the relative rate of RNA synthesis by increasing the rate of conversion of ribonucleoprotein particles to ribosomes and thereby decreasing their availability for regulating RNA synthesis by feedback inhibition. (auth)

14548 (BNWL-280, pp 92-5) AMINO ACID TRANSPORT IN NEUROSPORA CRASSA. Wiley, W. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Trypophan transport in Neurospora crassa is mediated by a specific transport system. The process is stereospecific, shows the typical substrate saturation kinetics for enzymic reactions and a sharp decrease in the rate of tryptophan uptake at low temperatures. The structural requirements apparently necessary for reaction with the binding site are an α-amino group next to a carboxyl, and a free-CH_2 group in the β position. (auth)

14549 (BNWL-280, pp 132-3) REACTOR EFFLUENT MONITORING, 1965. Olson, P. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Young chinook salmon were reared in 0, 2, and 4% reactor effluent at three different temperatures to determine effect on mortality, growth and uptake of radionuclides. There was no significant effect of temperature or effluent concentration on mortality, but warmer waters accelerated growth regardless of effluent concentration. The radionuclides detected in whole fish were related to effluent concentration, but not to temperature. (auth)

14550 (BNWL-280, pp 126-7) RADIONUCLIDES IN COLUMBIA RIVER BIOTA. Watson, D. G.; Cushing, C. E.; Perkins, R. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Measurements of the concentration of several reactor-produced radionuclides in Columbia River biota were made before and after closure of three Hanford reactors. A noticeable reduction of radionuclides in the biota was evident after reactor shutdown, but this may have been influenced by river temperature changes and channeling of effluent. (auth)

14551 (BNWL-280, pp 121-2) A SYSTEM FOR MEASURING RADIONUCLIDE UPTAKE AND TURNOVER IN PERIPHYTON. Cushing, C. E.; Porter, N. S. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

An apparatus is described which will continuously measure uptake and cycling of radionuclides between periphyton and a controlled aqueous environment. (auth)

14552 (BNWL-280, pp 113-15) TEMPERATURE EFFECTS ON ENERGY RESERVES IN TROUT. Dean, J. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Higher levels of lipid reserves were observed in cardiac muscle of trout acclimated to an environmental temperature of 5°C than 18°C, but red muscle, white muscle, and liver showed no significant effect of temperature. The 5°C fish had significantly higher glycogen levels in liver and cardiac muscle but showed no difference in red and white muscle. (auth)

14553 (BNWL-280, pp 118-20) METABOLISM OF ZINC IN A MARINE BENTHIC AMPHIPOD. Cross, F. A.; Dean, J. M.; Nakatani, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The metabolism of ^{65}Zn was examined in the marine benthic amphipod Anonyx sp. The uptake of ^{65}Zn from seawater was temperature dependent but did not vary significantly within the normal environmental temperature range. Anonyx sp. apparently cannot remove significant amounts of ^{65}Zn tightly bound to sediments. (auth)

14554 (BNWL-280, pp 112-13) TEMPERATURE EFFECTS ON CESIUM METABOLISM IN TROUT. Dean, J. M.; Nakatani, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Cesium-137, injected intravenously into trout acclimated to an environmental temperature of 5°C, was retained with a half-life of about 20 days, a much longer half-life than previously measured in 18°C acclimated fish. (auth)

14555 (BNWL-280, pp 107-8) EFFECT OF CLAY PARTICLES ON UPTAKE OF CESIUM BY PLANTS. Cline, J. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Cesium-137 moves easily from bentonite clay particles to plant roots when a complete and agitated water bridge connects the particles to the root. (auth)

14556 (BNWL-280, pp 104-6) RADIOIODINE ENVIRONMENTAL RELEASE STUDIES. Watson, C. R.; Cline, J. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The effective half-time of ^{131}I retention on pasture grass was about 8 days. Peak thyroid concentrations of ^{131}I in grazing dairy cattle occurred on the fourth day. (auth)

14557 (BNWL-280, pp 81-3) REMOVAL OF INTERNALLY DEPOSITED RADIONUCLIDES. Smith, V. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Deferoxamine (DFA) was not beneficial, by itself, or in combination with diethylenetriaminepentaacetic acid (DTPA), in preventing the deposition of ^{144}Ce in rat tissues. Nor were the chelating antibiotics, vancomycin, and cephalothin, or the surfactant, Pluronics F-68, of any benefit by themselves, or as an adjunct to DTPA treatment, in preventing deposition of ^{239}Pu. (auth)

14558 (BNWL-280, pp 97-8) ^{137}Cs IN THE FOOD CHAIN OF ESKIMOS. Hanson, W. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Cesium-137 body burdens of Anaktuvuk Pass, Alaska residents during the summer of 1965 were about 30% less than during 1964.

Lower amounts of ^{137}Cs in the people reflected a similar decrease of ^{137}Cs concentrations in caribou flesh, which serves as the natives' food base. (auth)

14559 (BNWL–280, pp 98-100) BIOLOGICAL HALF-TIME OF ^{137}Cs IN ESKIMOS. Hanson, W. C.; Eberhardt, L. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The biological half-time of ^{137}Cs in Alaskan Eskimos was investigated during the summer of 1965 by substituting domestic meat for caribou and sheep in their normal diet for 4 weeks. Whole-body counts and excreta measurements led to average half-time estimates of 40 days for children, 52 days for minors, and 64 days for adults. (auth)

14560 (BNWL–280, pp 115-17) ULTRASTRUCTURAL CHANGES IN FISH LIVERS ASSOCIATED WITH TEMPERATURE ACCLIMATION. Berlin, J. D.; Dean, J. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Morphological expression of proteinaceous materials, one of which may be plasma albumin, is increased in hepatocytes from cold acclimated fish livers as compared to similar cells from warm acclimated fish. This observation may have critical significance to an understanding of temperature acclimation in poikilotherms. (auth)

14561 (BNWL–280, pp 83-5) TRANSLOCATION OF SUBCUTANEOUSLY DEPOSITED PLUTONIUM. McClanahan, Beatrice J.; Ragan, H. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Following subcutaneous injection of $^{239}PuO_2$ in miniature swine, soft tissue concentrations of ^{239}Pu showed a continuing increase over a one year period. Treatments designed to alter translocation of ^{239}Pu(IV) nitrate in rats generally had little effect. Preliminary results of treatment with DTPA and DMSO are reported. (auth)

14562 (JPRS–38943) PROBLEMS OF CYBERNETICS, NO. 16, 1966. Lyapunov, A. A. (ed.). Translated from pp 1-248 of Problemy Kibernetiki, No. 16, Nauka, Moscow, 1966. 311p. (TT–66-35366). CFSTI $3.00 cy, $0.65 mn.

Various aspects of control problems in living organisms are considered. A discussion is presented of the mechanisms of the primary biological effects of ionizing radiation as related to certain concepts of biological cybernetics. The work of various investigators on genetic regulation of biochemical processes in the cell is reviewed. It is concluded that control signals from nervous and endocrine systems are effected through specific cell structures which are part of centers for storage and processing of information and that primary radiation injury of these structures and of the DNA control device may serve as the initial triggering mechanism of radiation damage in the organism. Some other topics discussed are: the problem of the integrity of living systems; linear ordering of genetic messages; evolution of animal behavior; equilibrium between genotypes in model populations of Drosophila melanogaster; adaptation polymorphism in populations of Adalia bipunctata (Coleoptera); on the problem of modeling the evolutionary process; mathematical models of elementary processes in biogeocenoses; on certain mathematical models of biogeocenoses; a model of coexistence of two biological species; on a mathematical model of biocenosis control; and homologous variability. (H.L.W.)

14563 (NP-tr–1479) ROLE OF PEROXIDES AND OXYGEN IN THE FIRST STAGES OF THE RADIOBIOLOGICAL EFFECT. SOME PROPERTIES OF THE OXYGEN EFFECT. Ardashnikov, S. N. Translated by J. E. Baker (Atomic Energy Research Establishment, Harwell, Eng.), from pp 146-52 of Rol' Perekisei Kisloroda v Nachal'nykh Stadiiakh Radiobiologicheskogo Effekta, Izdatel'stro Akademmi Nauk SSSR, Moscow, 1960. 11p. Dep. mn. CFSTI $3.00 cy, $0.65 mn, JCL $1.60 fs, $0.80 mf.

Some early unpublished experimental work concerned with the oxygen effect during the irradiation of various biological systems using natural radioactive materials as radiation sources is first described. This includes experiments with Vicia faba, tadpoles, mice etc. An oxygen effect was not observed in these alpha irradiations. Radical distributions and "active" collisions are discussed for alpha and for other types of radiation. The linear density of the ionisation created is the main factor causing differences in the oxygen effect with different types of radiation. The basic laws of the oxygen effect are enumerated. It is stated that investigation of the oxygen effect may be a powerful method, and sometimes the only method, for studying the primary processes of the mechanism of the action of radiation in complex biological systems. (auth)

14564 ANESTHESIA. LXIX. ANESTHESIA WITH DEUTERO ETHER. Krantz, John C. Jr.; Koski, Walter S.; Loecher, Claire K. (Johns Hopkins Univ., Baltimore). Biochem. Pharmacol., 15: 2119(Dec. 1966).

Since it was shown earlier that deuterated ethylene elicited anesthesia in dogs similar to that of ethylene, studies were aimed at determining if the same similarity of response prevailed between ether and deuterated ether had an isotopic purity of 99 at.%. Anesthesia was conducted on Swiss Webster albino mice, ICR strain. The anesthetic syndrome appeared to be identical for deuterated ether and its H analog. A concentration of 6 volume % vapor of the anesthetic provided a smooth anesthetic syndrome without threatened respiratory failure with each agent. Mass spectrometric analysis showed that the exhaled deuterated ether had not undergone atomic transfer with H from body tissues and was completely deuterated. The absence of deuterium exchange from deutero ether suggests that the anesthetic action is not dependent upon atomic exchange of ether with other molecules in the biological system, and that the syndrome is evoked by the intact molecule. This is compatible with the theories of anesthesia which involve relatively weak van der Waals attraction between the molecules of the anesthetic and molecules of compounds in the biological system, and not atomic exchange. (BBB)

14565 THE EMBRYONIC HEART SUBJECTED TO RADAR. Paff, George H.; Boucek, Robert J.; Nieman, Richard E.; Deichmann, William B. (Univ. of Miami, Coral Gables, Fla.). Anat. Rec., 147: 379-85(Nov. 1963).

To determine whether microwaves can damage tissue in the absence of undesirable heat levels, 106 isolated 72-hr embryonic chick hearts were subjected to radar waves at a frequency of 24,000 Mcps, a wavelength of 1.25 cm, and exposures of 478, 297, 167 and 74 mW/cm^2 for times varying between a few seconds and 3 min. The electrocardiogram (ECG) was taken as a continuous run before, during, and after radar treatment. The hearts were explanted in blood plasma on the surface of Saran sheet and microwaves were directed through the sheet at the heart. Where necessary, a stream of cold air was used to offset undesirable elevation of heat. At exposure of 478 and 297 mW/cm^2 damage from heating was swift and devastating. However, at an exposure of 167 mW/cm^2 it was possible to prevent elevation of temperatures above 38°C. The hearts showed damage in the ECG, i.e., shortening of the QT interval, increased height and breadth of the T wave, and the appearance of a large U wave. At 74 mW/cm^2 it was possible to control heat merely by maintaining an ambient temperature below 25°C. Of 25 hearts so exposed, all showed the same ECG changes. The conclusion was made that radar waves can damage tissue at exposures which do not raise the temperature to a harmful level. (BBB)

14566 EXPERIMENTAL STUDIES ON THE BIOLOGICAL RESPONSES OF MICE AND RABBITS TO THE SIMULTANEOUS ADMINISTRATION OF URANYL NITRATE AND ^{60}Co GAMMA IRRADIATION. STUDY 1. ON THE ACUTE BIOLOGICAL RESPONSES AFTER THE ADMINISTRATION. Fujii, Yoshio (Okayama Univ., Japan). Okayama Igakkai Zasshi, 78: 259-76 (Mar. 1966). (In Japanese).

The combined effects of the toxicity of U and external γ irradiation were studied in C57BL mice. Uranyl nitrate (5 or 10 mg U/kg) was injected intraperitoneally before exposure to ^{60}Co γ rays (325 or 650 R). The mice were divided into 8 groups: U1 (5 mg U/kg), R1 (325 R irradiation), U1R1 (5 mg U/kg + 325 R), U2 (10 mg U/kg), R2 (650 R), U2R2 (10 mg U/kg + 650 R), and controls. After the treatment, they were examined for survival rate, body weight, and kidney histology. Studies were also done with rabbits, divided into 4 groups. In the first group (U), 0.2 mg U/kg of uranium nitrate was injected intravenously; in the second group (R), 800 R of γ rays was given; in the third group (UR), U and γ rays in the same doses as the above were administered simultaneously; and the fourth group was the control. Hematologic parameters, blood catalase activity, serum phosphatase, serum creatinine, serum protein, nonprotein nitrogen, urine catalase activity, and amount of U excreted in urine were determined. The survival rate of mice for 30 days was for the group U1 80%, R1 100%, U2 30%, R2 20%, and U1R1 60%; all mice of the U2R2 group died within 7 days. Mouse kidney exposed to uranyl nitrate showed degeneration of the tubular epithelium and retention of protein in Bowman's capsule. In the groups exposed to γ irradiation combined with U treatment, additional effects were not seen. In rabbits, serum acid phosphatase increased in groups U and UR. Nonprotein nitrogen in blood increased in group UR. Catalase activity in blood and alkaline phosphatase in serum showed no changes in any groups. (BBB)

14567 HAIR GROWTH MEASUREMENT USING INTRADERMAL ^{35}S CYSTINE. Munro, Dowling D. (St. Mary's Hospital, London). Arch. Dermatol., 93: 119-22(Jan. 1966).

A new radioisotope method of measuring linear hair growth by the intradermal use of ^{35}S-labeled L-cystine, followed by autoradiography of hairs, was devised and was investigated in experimental animals and humans. It was shown to produce satisfactory results

without danger from radiation as the doses used are very small. In experimental animals, intraperitoneal or intravenous injection of ^{35}S-cystine resulted in detectable radioactivity in the hair follicles within a few minutes, and in the hair shafts several hours later. This incorporation of ^{35}S-labeled cystine may be detected by liquid scintillation counting of dissolved tissue or by autoradiography of the hair shaft or follicle. If two injections are given with an interval between them, the distance between the marks on the autoradiograph will represent the growth of hair in the period between injections. The method is superior to other ways of measuring linear hair growth, owing to its accuracy and cosmetic acceptability in human subjects. It is suitable for marking hairs at intervals during a variety of environmental conditions and drug therapy, while the hairs continue to grow undisturbed. (BBB)

14568 DISTRIBUTION OF MERCURY IN THE BRAIN AND ITS SUBCELLULAR UNITS IN EXPERIMENTAL ORGANIC MERCURY POISONINGS. Yoshino, Yoshikazu; Mozai, Toshiji; Nakao, Kiku (Tokyo Univ.). J. Neurochem., 13: 397-406 (May 1966).

The relation between ^{203}Hg content and histological changes in dog brain was studied after injection of methylmercury thioacetamide ($CH_3HgSCH_2CONH_2$) labeled with ^{203}Hg. The most noticeable histological change was observed in the calcarine area where the ^{203}Hg level was always higher than in other areas. In some dogs the ^{203}Hg content in the cerebellum was noticeably high, but this was not a constant finding. Chemical fractionation of the brain of the rat poisoned with the radioactive methylmercury compound revealed that almost all radioactivity resided in the protein fraction, there being little radioactivity in the lipid and nucleic fractions. Hydrolysis of the protein released ^{203}Hg. The distribution of radiomercury in the subcellular units was as follows: at an early stage after administration, radioactivity was the highest in the mitochondrial fraction, then in the microsomal fraction, and lowest in the supernatant fraction. But after 24 hr, the latter 2 fractions also exhibited high radioactivity. At that time (from 1 to 16 days), the average radioactivity for each fraction was 31% of the total radioactivity for the mitochondrial fraction, 26% for the microsomal fraction, and 24% for the supernatant. Almost all the radioactivity counted in the nuclear fraction was regarded as being due to the blood cells remaining in the brain after decapitation. Therefore, in the nucleus itself there was little radiomercury. A latent period was found to exist between the time when the concentration of the poison in the brain reached its peak and the development of nervous systems. (BBB)

14569 CYTOCHEMICAL EVALUATION OF METABOLIC INHIBITORS IN CELL CULTURE. Caspersson, T.; Farber, S.; Foley, G. E.; Killander, D.; Zetterberg, A. (Karolinska Institutet, Stockholm). Exp. Cell. Res., 39: 365-85(Sept. 1965).

Ionizing radiation and other cytostatic agents were used in the development of a method for the cytochemical evaluation of the mechanism of action of metabolic inhibitors in cell culture, utilizing the rapid-scanning high-resolution, automatically integrating biophysical instrumentation developed for cell population analyses. This method permits the in situ determination of the amount of DNA, RNA, and protein in individual cells in populations of heterogeneous cells, and the effects of the inhibitory agents on these biosynthetic processes. X rays and nitrogen mustard (HN2) were selected as agents which are primarily mitotic inhibitors; 5-fluorodeoxyuridine and mitomycin C as inhibitors of DNA synthesis; 5-fluorouracil, 5-fluorouridine, and actinomycin D as inhibitors of RNA synthesis; and puromycin and chloramphenicol as inhibitors of protein synthesis. Exposure to HN2 at a concentration of 0.8 μg/ml resulted in almost complete inhibition of mitosis. However, DNA synthesis continued, resulting in the accumulation of cells containing premitotic amounts of DNA. Similarly, synthesis of RNA and protein continued, resulting in cells containing 2 to 3 times the average amounts of RNA and protein per cell. Thus, as adjudged by cytochemical analyses, HN2 inhibits mitosis, but does not interfere with the continued synthesis of DNA, RNA, and protein; although the rate of such syntheses may be reduced. X irradiation at a dose of 5000 R resulted in an almost complete inhibition of mitosis, while DNA, RNA, and protein synthesis continued. The other agents were shown to be specific inhibitors of DNA, RNA, or protein. The results of cytochemical analyses of populations of cells exposed to these agents agreed, in general, with what is known of their mechanisms of action from other studies. (BBB)

14570 RADIOSTRONTIUM, RADIOPHOSPHORUS, STABLE STRONTIUM, STABLE CALCIUM, DNA, AND DNA-P IN RAM SPERMATOZOA. Aberg, Bertil; Gillner, Margot (Royal Veterinary Coll., Stockholm). Acta Physiol. Scand., 66: 106-14 (Jan.-Feb. 1966).

Radiostrontium uptake by spermatozoa and the relation between radiostrontium and spermatozoal DNA were investigated, as well as the normal content of DNA, DNA-P, Sr, and Ca in ram spermatozoa. The normal content of DNA in spermatozoa was found to be 2.9 pg per cell and the content of DNA-P 0.21 pg per cell. The ratio of stable strontium to stable calcium in spermatozoa was 1:118 and the ratio stable strontium to DNA-P 1:1846. The ratio stable calcium to DNA-P was 1:18. After intravenous administration of radiostrontium (^{89}Sr) to rams, a max concentration occurred in the spermatozoon on the 3rd to 7th day. At that time the ratio ^{89}Sr: DNA-P was 0.25×10^{-8}. After intravenous administration of radiophosphorus to rams the maximal ratio of ^{32}P: DNA-P was 0.17×10^{-6}. When 31.5 mCi of ^{89}Sr was administered intravenously to a ram, the sperm cells were dead between the 45th and 52nd day. At 8 weeks the sperm cell picture was normalized. Radiostrontium in the doses used (31.5 mCi of ^{89}Sr in one ram and 10 mCi in another) also caused clinical changes. Thus both animals developed leukopenia and neutropenia and the second ram died on the 61st day. At post mortem examination this ram showed definite signs of the radiation syndrome. The first ram was clinically healthy when sacrificed in the 11th week. A third ram which received 0.5 mCi of ^{85}Sr was clinically healthy during the whole experimental period. (BBB)

14571 INHALATION STUDIES IN GUINEA PIGS WITH RADIOACTIVE ZIRCONIUM WITH AND WITHOUT CARRIER ADDITION. Schmidtke, I. (Medizinische Universitaetsklinik, Freiburg i. B.). Zentralbl. Biol. Aerosol. Forsch., 11: 397-419(Feb. 1964). (In German).

Because of its physical half value time of 65 days the fission product ^{95}Zr comprises a relatively high fraction of tropospheric stratospheric, and local fallout. Its uptake, resorption, distribution, and excretion were studied in guinea pigs following inhalation administration of ^{95}Zr, carrier free and with carrier. Results with carrier-free ^{95}Zr were very similar to results obtained by other investigators who found that although it was relatively insoluble in body tissues a relatively high % was absorbed transpulmonarily. Immediately after administration the lungs contained ~20% of the recovered dose, and the skeleton ~10%. The ^{95}Zr was excreted essentially by way of the intestinal tract. After 4 weeks, 85% of the incorporated dose was excreted, and the lung retention amounted to ~22% of the initial value. As shown by histoautoradiograms the ^{95}Zr was deposited spottily throughout the alveolar septa. The addition of a 10^6 fold amount of nonradioactive carrier did not appreciably alter the distribution in the organism overall, and there was no significant increase in renal excretion. The deposition of inhaled particles in the respiratory tract tended to be located more in the cranial direction. The lung clearances during the first few days following inhalation were considerably slower than after administration of carrier free ^{95}Zr, and took place by way of the lymphatic system. After four weeks the ^{95}Zr contained in the lungs was still ~42% of the initial value. References cited, 55. (BBB)

14572 BODY WATER TURNOVER IN CATTLE WITH PARASITIC GASTROENTERITIS. Baker, Norman F.; Black, Arthur L.; Anand, Rajan S.; Fisk, Robert A. (Univ. of California, Davis). Exp. Parasitol., 17: 271-6(Dec. 1965).

Cattle were injected with ^3H_2O to study total-body water turnover and volume in normal and severely parasitized animals. The parasitized cattle were Hereford feeders which had acquired infections with Ostertagia ostertagi, Trichostrongylus axei, and Cooperia spp. while on permanent pasture. During the ^3H_2O turnover studies all animals had free access to feed and water. The mean total-body water volume in parasitized animals was 78% of the body weight. This represents an increase of 8 to 15% over that found in normal animals of similar age. The mean turnover rate (pool fraction per day) of body water in normal animals was 0.223, while that of parasitized cattle was 0.110. After therapy the turnover rate in parasitized cattle began to increase within 2 to 5 days. Between 20 and 30 days after treatment the mean turnover rate was 0.158. The reduced turnover rate of body water, assuming a steady state, revealed that in parasitized animals the mean daily water flux was only 13.4 liters, whereas in normal animals the mean daily flux would have been 27.2 liters. (BBB)

14573 EFFECTS OF ZINC DEFICIENCY PER SE AND OF DIETARY ZINC LEVEL ON URINARY AND ENDOGENOUS FECAL EXCRETION OF ^{65}Zn FROM A SINGLE INTRAVENOUS DOSE BY RUMINANTS. Miller, W. J.; Blackmon, D. M.; Powell, G. W.; Gentry, R. P.; Hiers, J. M. Jr. (Univ. of Georgia, Athens). J. Nutr., 90: 335-41(Nov. 1966).

Excretion of ^{65}Zn with time was studied in goats and cows after a single intravenous dose. In the first experiment the effects of a Zn deficiency per se on endogenous fecal and urinary ^{65}Zn excretion were determined using the same Zn-deficient diet for both deficient and normal animals. In the second experiment, effects of a normal and a Zn-deficient diet on ^{65}Zn metabolism were studied in normal animals. Fecal excretion of ^{65}Zn was higher in normal animals fed a normal diet containing 46 ppM zinc. Sp act. of fecal

Zn from animals fed the deficient diet was much higher, reflecting the much lower level of total fecal Zn. When fed the same diets, normal animals excreted more ^{65}Zn in feces than did Zn-deficient animals. However, the deficient animals excreted more ^{65}Zn in the urine, suggesting a possible pathological effect of the deficiency on the kidneys. Level of dietary Zn per se did not affect urinary excretion in normal animals. Urinary excretion of ^{65}Zn was highest the first day, decreased sharply the second day, and decreased gradually thereafter. Excretion of ^{65}Zn via urine was low, with the total for 13 days being less than 0.3% of the dose. Fecal excretion was highest the second and third days after dosing and decreased gradually thereafter. Level of ^{65}Zn in the blood declined rapidly immediately following dosing and very slowly after the first day. These studies indicate that both a low Zn diet and a zinc deficiency per se cause reduced endogenous fecal excretion of ^{65}Zn for at least 2 weeks after the Zn enters the blood, thus contributing to homeostasis of this element. (BBB)

14574 UPTAKE OF MIXED FISSION PRODUCTS BY MARINE FISHES. Baptist, John P. (Bureau of Commercial Fisheries Radiobiological Lab., Beaufort, N. C.). Trans. Amer. Fisheries Soc., 95: 145-52(Apr. 1966).

Uptake of fission product mixtures from seawater was studied in spot, Leiostomus xanthurus, and Atlantic croaker, Micropogon undulatus. Uptake from orally administered doses by croaker and bluefish, Pomatomus saltatrix, was also determined. Croaker and spot were kept in tanks containing 50 liters of radioactive seawater; the fission product concentration was adjusted to 1000 β cps/g. Availability of fission products to the fish was curtailed considerably by the formation and settling of radioactive particles in the water and by sorption to abiotic surfaces. Spot and croaker accumulated relatively low levels of radioactive material from seawater. Following a single oral dose, croaker assimilated a max of 14% in 4 hr, but 94% of the original dose was eliminated after 4 days. Bluefish assimilated only 3% of the cumulative dose of mixed fission products administered in shrimp meat on alternate days for 55 days. Of the amount assimilated from oral doses by croaker and bluefish, the largest concentrations were found in the internal organs. No individual radionuclides accumulated by the fish were identified, their presence being surmised only by considering characteristics of various radionuclides and factors affecting their accumulation. (BBB)

14575 ROLE OF ERYTHROPOIETIN IN CHANGES OF ERYTHROPOIESIS AFTER X-IRRADIATION IN RATS AND RABBITS. Klener, V. (Inst. of Radiation Hygiene, Prague). Physiol. Bohemoslov., 15: 385-90(1966).

In rats x irradiated with a whole-body dose of 400 R erythropoiesis sharply decreases between the 2nd and the 5th day and then rapid recovery takes place. Similar results were obtained in rabbits after irradiation with 600 R. Attempts were made to determine whether these changes in erythropoiesis after irradiation are controlled by erythropoietin (ESF). Changes in the ESF level after irradiation were studied in rabbits and non-protein plasma extract was tested in nonirradiated starving rats. The response of irradiated rats to ESF was investigated in rats which were given rabbit ESF. The level of ESF in the plasma of rabbits was investigated on the 4th, 8th, and 11th day after 600 R by bioassay in the starving rats by means of ^{59}Fe uptake in erythrocytes. A significant increase in erythropoietic activity of plasma was found on the 4th day following exposure. In addition, the response of rats irradiated with 400 R to the administration of rabbit ESF was determined on the 3rd, 7th, and 11th day following irradiation and the results were compared with the response of the irradiated controls injected with the plasma extract from control nonirradiated rabbits. Erythropoiesis was completely suppressed on the 3rd day after irradiation and at that time no response was observed to exogenous ESF. At 7 and 11 days following irradiation, increased erythropoiesis was found both after the injection of ESF and after injection of plasma from nonirradiated rabbits. These results are not sufficient to clarify the role of ESF in the regeneration of erythropoiesis after irradiation. (BBB)

14576 CHANGES IN ERYTHROPOIESIS AFTER WHOLE-BODY X-IRRADIATION IN RATS AND RABBITS. Klener, V. (Inst. of Radiation Hygiene, Prague). Physiol. Bohemoslov., 15: 378-84(1966).

To elucidate the role of erythropoietin in pathological changes in erythropoiesis after irradiation, radioiron (^{59}Fe) uptake was investigated in the blood of rats after exposure to 400 R and in the blood of rabbits after exposure to 600 R. The x-ray doses used were sufficient to ensure an intense hematopoietic stimulus without reaching the $LD_{50/30}$, so that most of the animals survived the whole experimental period. The erythropoietic activity was determined at various time intervals up to the 11th day following irradiation. The first day after irradiation the animals were injected with radioiron 2 hr after exposure, after 18 hr blood was drawn for the determination of ^{59}Fe uptake and hematological examination. Other groups were followed at 24- and 48-hr intervals. It was evident from the results that between the 2nd and the 5th day after irradiation a significant decrease in ^{59}Fe uptake in the whole blood occurred and all the measured activity was found in the plasma. On the following days the values returned rapidly to the control level and on the 11th day after irradiation the values did not differ significantly from those of nonirradiated animals. The reticulocyte counts followed roughly the time course of the ^{59}Fe uptake in the blood, a decrease from the 2nd to the 5th day being statistically significant in comparison with the controls, but the values from the 9th to the 11th day did not differ from the controls significantly. During the whole course of the experiment, up to the 11th day after irradiation, slight gradual decreases of erythrocytes, hemoglobin, and hematocrit were evident. The course of changes in rabbits after exposure to 600 R was similar, only individual values were quantitatively different from the response in rats. (BBB)

14577 EFFECT OF VITAMIN D ON ^{65}Zn ABSORPTION, DISTRIBUTION, AND TURNOVER IN RATS. Becker, W. M.; Hoekstra, W. G. (Univ. of Wisconsin, Madison). J. Nutr., 90: 301-9(Nov. 1966).

The effect of dietary vitamin D on the absorption, distribution, and turnover of ^{65}Zn in growing rats was studied. In the first experiment, whole-animal retention of oral ^{65}Zn by rats fed zinc-supplemented, but not zinc-deficient, diets was slightly increased by continuous supplementation with vitamin D. Retention of injected ^{65}Zn was not similarly enhanced, suggesting a possible effect on ^{65}Zn absorption. In the second experiment ^{65}Zn absorption and turnover were determined by more detailed analysis of whole-animal ^{65}Zn retention patterns, and the distribution of oral and injected ^{65}Zn at 60 hr postadministration was examined. The effect of vitamin D on uptake of oral ^{65}Zn was most pronounced when the vitamin was suddenly added to the diet of previously vitamin D-deficient rats. At 60 hr skeletal, but not soft tissue, uptake of either oral or injected ^{65}Zn was significantly increased by the supplementation of vitamin D to vitamin D-deficient rats. However, skeletal sp act. (% ^{65}Zn per g) was increased by vitamin D only with the orally administered ^{65}Zn. The increased absorption of dietary zinc attributed to vitamin D probably results, not from a direct effect of the vitamin, but from a homeostatic response to the the increased need for zinc which accompanies enhanced skeletal growth and calcification. (BBB)

14578 ACCUMULATION OF MIXED FISSION PRODUCTS BY MARINE ORGANISMS: DISCUSSION. Saiki, Masamichi; Umezu, Takeshi (National Inst. of Radiological Sciences, Chiba, Japan). pp 284-6 of Proc. Second Intern. Water Pollution Res. Conf., Tokyo, 1964. New York, Pergamon Press, 1965.

In a discussion of the uptake of mixed fission products by marine organisms, some data on individual radionuclides such as ^{65}Zn and ^{55}Fe, which are rarely found in fission products, are reported. They may have an important effect on the radioactive contamination of marine organisms. This effect is suggested by analytical results on fish caught in the Pacific Ocean. The liver of a highly contaminated tuna, caught 80 mi from Bikini Atoll during October, 1956, had the following radionuclide concentrations: 5×10^3 pCi/g of ^{55}Fe, 5×10^2 pCi/g of ^{65}Zn, 1.2×10^2 pCi/g of ^{115m}Cd, 22 pCi/g of ^{54}Mn, 20 pCi/g of ^{90}Sr, and traces of ^{140}La. These data are for a particularly highly contaminated fish, and do not represent the contamination level of fishery products from the Pacific Ocean. Other data for 19 tunas caught in the mid-Pacific Area during August 1962, soon after the nuclear tests, were as follows: 0.1 to 0.4 pCi/g of ^{65}Zn, 0.06 to 0.15 pCi/g ^{60}Co, 0.3 to 1.3×10^{-3} pCi/g of ^{90}Sr, and 4.9 to 16.7×10^{-3} pCi/g of ^{137}Cs. The role of phytoplankton on the cycle of radionuclides in a marine environment is discussed, as well as some experiments on the uptake of radionuclides by marine bacteria and yeasts. It was concluded that the most effective accumulators of radionuclides in the oceanic realm are the members of the zooplankton family. (BBB)

14579 ABOVEGROUND PLANT PARTS AS A PATHWAY FOR ENTRY OF FISSION PRODUCTS INTO THE FOOD CHAIN WITH SPECIAL REFERENCE TO ^{89} ^{90}Sr AND ^{137}Cs. Bukovac, M. J.; Wittwer, S. H.; Tukey, H. B. (Michigan State Univ., East Lansing). pp 82-109 of Radioactive Fallout, Soils, Plants, Foods, Man. Fowler, Eric B. (ed.). Amsterdam, Elsevier, 1965.

The absorption of radionuclides by plants, foliar absorption and subsequent distribution, recovery of ^{90}Sr and ^{137}Cs in fruits and seeds after foliar application, redistribution in plant development, comparison of aboveground and root absorption, and loss of fission products from leaves and fruit by leaching were studied. Both ^{89}Sr and ^{137}Cs were readily absorbed by the bean leaf; however, the rate was much greater with ^{137}Cs. Comparative absorption percentages were 10 and 45 after 24 hr and 40 and 80 after 192 hr for ^{89}Sr and

^{137}Cs, respectively. Absorption curves for both fission products were approaching an asymptote after 192 hr. The translocation out of the absorbing leaf was strikingly different for ^{89}Sr and ^{137}Cs. Less than 0.2% of the total ^{89}Sr applied to the primary leaf of the bean was detected after 192 hr in the remainder of the plant. The most notable differences in ^{137}Cs distribution, compared to ^{89}Sr, were the higher percentages of cesium found in reproductive structures and the lesser percentages in the stems and leaves. Of the total ^{89}Sr and ^{137}Cs applied at the seedling or flowering stage, 65 times more ^{137}Cs than ^{89}Sr was translocated to the carpels and seeds. Fission products, when absorbed by the foliage, may remain within the absorbing organ or be translocated to other parts. If transport occurs, an active mechanism via the phloem probably is involved. In contrast, fission products absorbed by roots ascend with the transpiration stream via the xylem, and generally become distributed throughout the plant. The redistribution of root-absorbed ^{89}Sr and ^{137}Cs from initial sites of accumulation in the developing bean plant is described. The most striking difference between ^{137}Cs and ^{90}Sr is in the distribution subsequent to foliar absorption. Cesium is mobile and strontium is not. Consequently, foliar contamination with ^{137}Cs may pose a greater hazard than with ^{90}Sr. In addition to absorption by plant surfaces upon which cesium is originally deposited, transport of the absorbed cesium to subsequently developing tissues would be much greater than for strontium. Furthermore, less ^{137}Cs is generally absorbed from the soil. Apparently, cesium is tightly absorbed to soil colloids and is not readily available for root uptake. (BBB)

14580 AN AGAROSE-GEL ZONE ELECTROPHORESIS TECHNIQUE FOR IN-VIVO PROTEIN BINDING STUDIES OF RADIOACTIVE ISOTOPES. McGlashan, D. A. K.; Pullen, B. R. (St. George's Hospital, London). J. Chromatogr., 26: 346-9 (Jan. 1967).

Studies of protein binding of isotopes in serums of low activity were made. An apparatus using agarose gel is described, which was used to separate 3 ml or more of serum on a single run with resolution comparable with that of paper. A separate apparatus is described, which permits simple and efficient recovery of protein from the gel. Agarose blocks of 2 cm depth or more were used for electrophoretic separation of serum proteins without cooling. The separation and resolution by this method is adequate for preparative work or projects involving detection of small quantities of protein binding isotope. The system was successful in the study of in vivo binding of ^{131}I metabolites following administration of tracer dosage ^{131}I. Results obtained on hyperthyroid patients were similar to those reported where micro-techniques were used. (D.H.M.)

14581 EVIDENCE FROM UV INACTIVATION KINETICS FOR DISCRETE CELLULAR SITES THAT CODE FOR INTERFERON SYNTHESIS. Cogniaux-LeClerc, Jacqueline (Institut Pasteur du Brabant, Brussels); Levy, Allan H.; Wagner, Robert R. Virology, 28: 497-9(Mar. 1966).

The effect of uv radiation of the interferon-producing capacity of L cell cultures subsequently infected with Newcastle disease virus (NDV) was investigated. Doses of uv varying from 300 to 1100 erg/mm^2 progressively reduced interferon production of the cells. To determine whether other cellular functions were altered by uv light, replicate L cell cultures were infected at a multiplicity of 50 with vesicular stomatitis virus immediately after irradiation and were incubated for 8 hr. The virus yields recorded revealed that uv doses up to 2200 erg/mm^2 did not appreciably reduce the capacity of L cells to support viral replication. With the knowledge that DNA repair can occur spontaneously in irradiated bacterial cells, evidence was also sought for similar recovery of interferon-synthesizing function after uv irradiation. Accordingly, cells were incubated in the dark for 18 hr following uv irradiation and then infected with NDV. Interferon production was even lower than that in comparable cells induced immediately after irradiation, indicating no target repair under these experimental conditions. Attempts at photoreactivation by white light were also unsuccessful, partially owing to failure of many cells to survive. The results of these experiments are consistent with the existence of a discrete cellular site (or sites) that codes for interferon synthesis. Considering the limitations of the interferon assay procedure, the uv inactivation curves do not appear to deviate significantly from one-hit kinetics over a narrow uv dose range. The data suggest that each effective uv hit damages a single interferon-synthesizing target, which must be located in cellular DNA. (BBB)

14582 SURVIVAL OF IRRADIATED ERYTHROCYTES AFTER TRANSFUSION TO ISOLOGOUS MICE. Cividalli, Gabriel; Horn, Yoav (Hadassah Univ. Hospital, Jerusalem). Israel J. Med. Sci., 2: 560-3(Sept.-Oct. 1966).

The effect of large doses of radiation on red blood cells was studied to investigate the cause of anemia which rapidly occurs in some patients undergoing radiotherapy. Red blood cells from C57B1/6jax mice were labeled with ^{51}Cr, irradiated (^{60}Co) with doses 1000 to 40,000 rad, and transfused to isologous mice. The ^{51}Cr activity in the blood of the recipient mice, followed for 25 days, decreased exponentially with time, after transfusion of irradiated as well as of control erythrocytes. The decrease in sp act. was, however, more rapid as the radiation dose was increased. The rate of red blood cell destruction, represented by the slope of the ^{51}Cr act. curves, was increased throughout the entire life span of the irradiated erythrocytes. The linearity of the curves indicated that all the cells were damaged. Some (perhaps the older ones) were destroyed quickly, while others (perhaps the younger) survived for a longer time; but even in the cells surviving for more than 2 weeks, a constantly enhanced rate of destruction was apparent. It seemed, therefore, that no repair of radiation damage takes place. The experiments reported show a clear dose dependence for red blood cell survival at various periods after irradiation. The correlation between radiation dose and decrease in life span was, however, not linear, unlike that with intracellular electrolyte changes. (BBB)

14583 EFFECT OF HIGH PRESSURE OXYGEN ON RADIOSENSITIVITY OF EHRLICH'S TUMOR IN MICE AFTER IMMUNOLOGICAL APPROXIMATION. van den Brenk, H. A. S. (Cancer Inst., Melbourne). Brit. J. Cancer, 15: 61-84(1961).

The effect of breathing oxygen at high pressure (OHP) (45 lb/in.^{2} gauge pressure) on radiosensitivity of Ehrlich's tumor (solid form) in vivo was studied. Recipient mice were given 400-R whole-body irradiation before inoculation of tumor cells to cause so-called immunological approximation and a substantial reduction in the homograft reaction. The effect of irradiation was based on cure of tumors 8 weeks after irradiation. Regression curves showed that OHP caused a significant increase in radiosensitivity (radiocurability) with a dose reduction by a factor of 2.4. Tissue reactions assessed 4 weeks after irradiation were increased in OHP by factors ranging from 1.6 to 2.2. Evidence is provided that in mice breathing air at atmospheric pressure, tissue radiosensitivity approached levels corresponding to min (anaerobic) values. The results of polarographic measurements of oxygen tension in normal tissues and tumors in animals breathing air and OHP are described and discussed. The polarographic method is of limited value in providing absolute values of oxygen tension in tissues. (BBB)

14584 THE NEW FORMATION OF DNA IN RAT EMBRYOS AFTER A SINGLE X IRRADIATION OF THE MATERNAL ANIMAL. AUTORADIOGRAPHIC STUDIES. Wegner, G. (Univ., Freiburg i. B.). Bull. Schweiz. Akad. Med. Wiss., 22: 184-96(1966). (In German).

Pregnant rats were given a 150-R dose of 180-kv x rays on the 11th day of gestation, a time when organogenesis is at a peak. Autoradiographic investigation of new DNA synthesis in the embryo was carried out. From 2 to 15 hr later, inhibition of DNA synthesis was noted. According to ^{3}H-thymidine labeling investigations, a reduction of 70% in the brain region and 50% in heart and intestinal regions was recorded. After 24 hr a relative increase of the number of DNA-synthesizing cells in the brain region was noted. There was a marked reduction of mitosis up to 24 hr, with a decrease of mitosis in the brain region up to 3 days. Up to 5 days DNA synthesis remained low, accompanied by degenerative cell changes in some zones of the tel-, di-, and mesencephalon. Hydrocephalus occurred. Cellular disturbances after irradiation on the 9th day of development were characterized by a delay of DNA synthesis, a higher pycnosis incidence, and a strong reduction of mitosis. In these irradiated animals, severe malformations were seen. (BBB)

14585 MODE OF ORIGIN AND DISAPPEARANCE OF AN ERYTHROPOIETIC PHASE IN RAT SPLEEN AFTER WHOLE-BODY IRRADIATION. Stodtmeister, R.; Fliedner, T. M. (Institut fuer Hamatologie, Freiburg i. B.). Schweiz. Med. Wochenschr., 96: 1280-2(Sept. 24, 1966). (In German).

The erythroblast count in rat spleen was determined after irradiation of the animals with 500-, 600-, 700-, or 800-R doses of 15-MeV electrons or ^{60}Co γ rays. In this way, erythropoiesis in 94 spleens was studied for 42 days following whole-body irradiation. Within 2 days after irradiation, at the dose levels studied, the few erythroblasts normally present disappeared completely. Erythropoiesis was found to be present up to the 10th day only after the irradiation dose was higher than 700 R. This erythropoiesis developed initially around the lymphocyte-depleted trabeculae and later in the pulp. During regeneration of the lymphocytic tissue, erythropoiesis appeared to be displaced by lymphocytes, particularly after the 35th postirradiation day. During the first 3 weeks after irradiation erythropoiesis appeared in the spleen in proportion to the degree of anemia, suggesting that the observed erythropoiesis in the spleen is of a compensatory nature. (BBB)

14586 PHOTOINDUCED DNA-PROTEIN CROSS-LINKS AND BACTERIAL KILLING: A CORRELATION AT LOW TEMPERATURES. Smith, Kendric C.; O'Leary, Mary E. (Stanford Univ., Palo Alto, Calif.). Science, 155: 1024-6(Feb. 24, 1967).

The increased sensitivity of Escherichia coli to killing by ultraviolet irradiation when frozen and the variation in this sensitivity as a function of the temperature during irradiation were correlated with changes in the amount of DNA that was cross-linked to protein by ultraviolet light. These variations in sensitivity to killing do not correlate with the production of thymine dimers. (auth)

14587 RADIATION OF HEMOCYANIN: INACTIVATION AND REACTIVATION OF OXYGEN-CARRYING CAPACITY. Schubert, Jack; White, E. R. (Univ. of Pittsburgh). Science, 155: 1000-3 (Feb. 24, 1967).

Oxygen-carrying capacity of hemocyanin from Limulus and Busycotypus (Busycon) decreases with increasing radiation, giving initial yield values for $G(-O_2)$ of 1.1 and 1.0, respectively. High radiation doses regenerate this capacity of Busycotypus hemocyanin. These effects are attributed largely to the dual nature of hydrogen peroxide, which, at low concentrations, oxidizes protein-bound copper and at high concentrations, that is, at high doses, reduces oxidized copper. The ability of hemocyanin to decompose hydrogen peroxide is relatively unaffected by irradiation, which suggests that copper atoms at the active sites are not all equivalent. The catalase-like activity of Busycotypus hemocyanin can be simulated by amino acid chelates of copper, including arginine, histidine, and glycine. (auth)

14588 USE OF RADIOACTIVE TRACERS TO DETERMINE THE PROTECTIVE EFFECT OF CAVITY LINERS. Langeland, Kaare; Langeland, Leena Kaarina (State Univ. of New York, Buffalo). J. Dent. Res., 45: 1233(July-Aug. 1966).

A new method, employing ^{3}H labeling, was used to evaluate the protective effect of cavity lining materials. Tritium was tagged to the monomer of self-curing acrylic filling material. After insertion of the filling material into experimentally prepared cavities in 12 monkey teeth, the teeth were extracted after 83 days and placed in 10% formalin. After 2-hr prefixation, all fillings were removed and the teeth were fixed for 2 days, decalcified, embedded in paraffin, and sectioned at 5 μ. The sections were subsequently coated with emulsion for autoradiography. In all teeth, penetration of the monomer labeled with ^{3}H could be observed in the dentinal tubules next to the cavity, indicating that the monomer represents the harmful component. The method is suggested as a means of testing the effect of filling materials on the pulp in vivo, and to determine the filling material component that is harmful and the permeability of a liner. (TSS)

14589 NEUTRON-IRRADIATED ENAMEL IN DISSOLUTION STUDIES. Cutress, T. W.; Healy, W. B.; Allison, H. (Eastman Dental Dispensary, Rochester, N. Y.). J. Dent. Res., 45: 819-24(May-June 1966).

The behavior of neutron-irradiated enamel in dissolution studies was measured by chemical and radioactivity methods. The percents of orthophosphate and nonorthophosphate forms of ^{32}P in irradiated samples of enamel and calcium phosphate were determined. Orthophosphate compounds of enamel, upon irradiation with slow neutrons, yielded a radioactive product, the ^{32}P content of which was only partly in the orthophosphate form. Wide discrepancies observed between results by colorimetric and radioactive methods indicated the need for caution in interpreting results obtained with radioactive enamel. Less than 1×10^{-6}% of the total ^{31}P atoms were converted to ^{32}P during irradiation, an insignificant fraction from the point of view of colorimetric or gravimetric analysis. In solubility studies in which only part of the enamel was dissolved, discrepancies between colorimetric and radioactive methods appeared. Until all the enamel was dissolved the radioactive method gave variable and overall lower results. Neutron activation of teeth with subsequent measurement of ^{32}P in solution as a measure of solubility has advantages in enamel solubility studies since it enables a distinction to be made between phosphorus (^{32}P) atoms removed from enamel and other sources of phosphorus (^{31}P) in the decalcifying solution. The results suggest, however, that ways of minimizing or eliminating the errors noted here must be found before this method can be used with confidence. (BBB)

14590 ACCUMULATION OF MIXED FISSION PRODUCTS BY MARINE ORGANISMS. Rice, T. R.; Baptist, J. P.; Price, T. J. (Bureau of Commercial Fisheries, Beaufort, N. C.). pp 263-75 of Proc. Second Intern. Water Pollution Res. Conf., Tokyo, 1964. New York, Pergamon Press, 1965.

Results are reported on studies conducted to: follow the decay characteristics and to identify the strongest β emitters of two samples of mixed fission products; measure the rate of particle formation of fission products in sea water; delineate the ecological role of phytoplankton in the cycling of fission products in a marine environment; determine the amounts of β activity accumulated by marine animals, from different trophic levels, used as seafood by man; compare the ratio of the β to the γ activity simultaneously accumulated by these animals; and identify the tissues of these animals containing the highest concentrations of radioactivity. In two fission product mixtures, one at age 28 days and the other at age 302 days, the most energetic β emitter was ^{144}Pr. It accounted for 11.5% of the β activity of one sample and 44% in the older sample. When mixtures of fission products were added to sea water, there was an appreciable loss of radioactivity from the water as a result of particles settling and carrying the adsorbed radioactivity with them. The uptake of fission products by phytoplankton, Nitzschia closterium and Carteria sp.; oysters, Crassostrea virginica; bay scallops, Aequipecten irradians; shrimp, Penaeus setiferus; and fish, Micropogon undulatus, was measured. Most of the radioisotopes in the mixtures of fission products tested became associated with the cells of the species of algae used. Thus, algae can accumulate radioisotopes whether they occur in the soluble or particulate state. Even undigested radioactive algae in the digestive tract of the oyster would be a source of activity to man. The concentration of fission products in the muscle tissue, presumably isotopes in the soluble state, was found to be relatively low in scallops, shrimp, and fish species that are eaten by man. The adductor muscle of the scallop had a β-concentration factor of 11 and a γ-concentration factor of 20. The β-concentration factor of the muscle of the shrimp was 10.2 and γ only 1.8, while the muscle of fish had a β-concentration factor of less than 1. (BBB)

14591 TRANSFER OF FALL-OUT RADIONUCLIDES FROM DIET TO MAN. Wasserman, R. H.; Lengemann, F. W.; Thompson, J. C. Jr.; Comar, C. L. (Cornell Univ., Ithaca, N. Y.). pp 204-44 of Radioactive Fallout, Soils, Plants, Foods, Man. Fowler, Eric B. (ed.). Amsterdam, Elsevier, 1965. (TID-22642).

The metabolism of radiostrontium, discrimination factors in man and animals, levels of ^{90}Sr in the human diet, the metabolism of radiocesium and radioiodine, and the levels of radionuclides in dietary items are reviewed. Consideration is given to the contribution of various food sources (milk and nonmilk) to the total intake of fission products by the human population. Some countermeasures are also mentioned that could be instituted if concentrations of fission products in foods increase to a level where action is deemed necessary. A description of the comparative behavior of calcium and strontium in various physiological systems is provided. An assessment is given of the intake of ^{90}Sr by various segments of the human population. The record of radionuclide contamination of the diet is illustrated by the $^{90}Sr/Ca$ ratios during the period 1955 to 1963. Methods for reduction of radionuclide levels in marketing channels are discussed. (TSS)

14592 MECHANISM OF VITAMIN B_{12} UPTAKE BY ERYTHROCYTES. Retief, Francois P.; Gottlieb, Chester W.; Herbert, Victor (Mount Sinai Hospital, New York). J. Clin. Invest., 45: 1907-15(Dec. 1966).

Serum-mediated B_{12}–^{57}Co uptake by reticulocyte-rich erythrocytes appeared to represent rapid adsorption to the red cell surface; ionic calcium or magnesium was essential for this reaction, but strontium could partially replace these cations. In the test system used, B_{12}–^{57}Co uptake was maximal after 20 minutes' incubation, with near maximal adsorption during the first 5 minutes. Uptake increased with a rising reticulocyte count, but mature erythrocytes could also adsorb small amounts of B_{12}–^{57}Co. Trypsin and papain reduced B_{12} uptake, but metabolic poisons had no effect. Na_2 EDTA and trypsin could elute virtually all B_{12}–^{57}Co previously adsorbed to erythrocytes; elution was much less complete with serum and saline. B_{12}–^{57}Co taken up from a saline medium was less than from serum, did not concentrate in red cell stroma (unlike B_{12}–^{57}Co from serum), did not show calcium or reticulocyte dependence, and could not be eluted by Na_2 EDTA. It is suggested that two mechanisms exist for B_{12} uptake by erythrocytes analogous to the dual mechanisms for B_{12} transport across the intestinal mucosa: calcium- and/or magnesium-dependent, carrier glycoprotein-mediated transfer to receptors on the cell surface, operative primarily in the presence of physiologic quantities of B_{12} and simple diffusion independent of receptor sites (primarily operative in the presence of excess unbound B_{12}). (auth)

14593 DISTRIBUTION OF ^{95}Nb IN TISSUES AND LIVER SUBCELLULAR FRACTIONS OF RAT. Misra, U. K. (Hammersmith Hospital, London). Indian J. Exp. Biol., 5: No. 1, 23-6 (Jan. 1967).

The distribution of intravenously injected carrier-free ^{95}Nb has been studied in liver, kidney, spleen and heart tissues and liver subcellular fractions of rats (John's strain of Wistar) as a

function of time. The elimination of ^{95}Nb from plasma, liver and heart was quite rapid whereas from spleen and kidney it was quite slow. The results of Sephadex G-25 column chromatography and dialysis of plasma showed that ^{95}Nb is bound to plasma proteins. The distribution of ^{95}Nb in liver subcellular fractions showed that ^{95}Nb is taken up by nuclei, mitochondria, microsomes and supernatant. (auth)

14594 FREE RADICAL FORMATION IN AMINO ACIDS EXPOSED TO THERMAL HYDROGEN ATOMS. Snipes, Wallace; Schmidt, Jack (Pennsylvania State Univ., University Park). Radiat. Res., 29: 194-202(Oct, 1966).

Free radicals are formed in all the naturally occurring amino acids on their exposure to thermal hydrogen atoms. For most amino acids the ESR spectra of radicals formed by this method show the same basic structure as the spectra from samples exposed to γ-rays. One notable exception is leucine, for which hydrogen atom exposure produces only one of the radicals produced in this compound by γ-rays. Approximate dihedral angles which the methylene protons make with the carbon p-orbital in which the unpaired electron is located have been calculated. An anomalous oxygen effect for radicals produced by hydrogen atom exposure indicates that the absence of an oxygen effect for some γ-irradiated compounds may be due to limited diffusion of molecular oxygen into the crystal lattice. (auth)

14595 GROWTH, PROTEIN METABOLISM, AND SOLUTE UPTAKE: THE SIMULTANEOUS ABSORPTION OF PROLINE AND CESIUM BY ASEPTICALLY CULTURED TISSUE. Steward, F. C.; Lyndon, R. F. (Cornell Univ., Ithaca, N. Y.). New Phytol., 64: 451-76(Oct, 1965).

The uptake of radiocesium and an amino-acid precursor was studied in potato and carrot. Growing explants were simultaneously supplied with ^{137}CsCl and ^{14}C-proline in the presence and absence of some inhibitors of growth, namely 2,4-dinitrophenol, gramicidin-S, and an inhibitor formed by autoclaving urea with the culture medium. In the absence of inhibitors the rates of uptake of ^{14}C-proline and ^{137}Cs changed in parallel after a brief initial period. The general effect of all 3 inhibitors was to inhibit the absorption of both ^{137}Cs and ^{14}C-proline and the subsequent incorporation of the proline into protein and its conversion there to hydroxyproline. However, in detail the effects of the inhibitors were not identical. When dinitrophenol was applied, an initial, but transient, stimulation of proline absorption was observed whereas ^{137}Cs absorption was inhibited immediately. Gramicidin-S inhibited both ^{137}Cs and proline absorption, but protein synthesis continued for a while from endogenous reserves. After 8 hr, rapid absorption of proline was resumed but it was completely oxidized to carbon dioxide. The urea inhibitor suppressed proline absorption but allowed ^{137}Cs absorption to continue at a reduced rate. The data suggest that the phase of absorption which was studied was primarily that of the passage of solutes into the cytoplasm. The relation between the absorption of proline and ^{137}Cs on the one hand, and between these processes and protein synthesis on the other, are discussed in the light of other work on ion uptake by cells and of the known behavior of nucleic acids in carrot explants. A possible carrier role of the ribonucleic acids, especially the soluble RNAs is suggested. The processes of solute absorption and protein synthesis are considered in terms of their integration with the organization of the cell as a whole. (BBB)

14596 ULTRASTRUCTURAL AND CYTOCHEMICAL CHANGES IN SPERMATOGONIA AND SERTOLI CELLS OF WHOLE-BODY IRRADIATED MICE. Hugon, J.; Borgers, M. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Anat. Rec., 155: 15-31 (May 1966).

Findings on the early ultrastructural changes and on the localization of acid phosphatase in the spermatogonia and Sertoli cells of mice, after a single dose of x rays, are reported. Adult males of strain CBA/C57Bl received 400 R as whole-body irradiation, and were sacrificed 1, 2, 4, 8, 16, 24, and 48 hr later. The first changes observed in spermatogonia were: dilatations of the smooth endoplasmic reticulum, moderate enlargement of the mitochondria, and swelling of the nuclear membranes. In a later stage, the injured spermatogonia were phagocytized by the adjoining Sertoli cells, where the complete involution took place. A study of the acid phosphatase localization showed that the numerous dense bodies, appearing in the Sertoli cells in the first hours after irradiation, were heavily loaded with reaction product. They played an important part in the resorption of the phagocytized spermatogonia. (BBB)

14597 IN VIVO EXPERIMENT ON THE METABOLISM OF CESIUM IN HUMAN BLOOD WITH REFERENCE TO RUBIDIUM AND POTASSIUM. Yamagata, Noboru (Inst. of Public Health, Tokyo); Iwashima, Kiyoshi; Nagai, Teruo; Watari, Kazuo; Iinuma, Takeshi A. J. Radiat. Res., 7: 29-46(Mar. 1966).

Two single doses of coupled radioisotopes of ^{132}Cs–^{86}Rb and ^{132}Cs–^{42}K were orally administered to a human subject. Body retention, urinary and fecal excretions as well as the plasma and erythrocyte contents of radioisotopes were determined. The proportion of urinary to fecal excretion was found different in cesium and rubidium, the urinary excretion being 85.3% of the total in the former and only 68.1% in the latter. Loss of cesium in the sweat amounted to 1.5 and 3.5% of the total excretion for the first two days. Uptake by the plasma of oral dose was rapid and the whole blood content reached maximum 11.4% of the dose of cesium at 1 hour, while 2.9 and 2.4% respectively of rubidium and potassium was reached. The levels in the erythrocytes seemed to grow at a slower rate in cesium than in the other alkali elements. The different feature of blood metabolism found in the alkali elements was interpreted by the slow rate of clearance of ingested cesium from blood. Daily fluctuations of fall-out ^{137}Cs in blood and the errors involved in the assessment of the total body burden of ^{137}Cs by blood analysis are also discussed. (auth)

14598 MECHANISM OF PROLONGED AFTERGLOW OF ULTRAVIOLET IRRADIATED SOLUTIONS OF SERUM ALBUMIN. Sapezhinskii, I. I.; Silaev, Yu. V.; Dontsova, E. G. (Inst. of Chemical Physics, Moscow). Biophysics (USSR)(Engl. Transl.), 10: 476-80(1965).

Translated from Biofizika, 10: 429-32(1965).

The kinetic patterns of prolonged afterglow induced by uv exposure of solutions of serum albumin were determined with a flow apparatus. A set of light filters established that the afterglow spectrum lies in the region of 400 to 500 mμ. Results indicated that the intensity of the afterglow depends on the presence of oxygen in the system at the time of irradiation, the pH of the solution, and the recombination of free peroxide radicals formed during irradiation. (C.H.)

14599 COMPARISON OF THE EFFECTS OF GAMMA-RAYS AND MALEIC HYDRAZIDE ON ENZYME SYSTEMS OF MAIZE SEED. Endo, T. (Indiana Univ., Bloomington). Radiat. Bot., 7: 35-40(Feb, 1967).

Effects of γ rays on enzyme systems of maize seed were zymographically examined and compared with those of maleic hydrazide (MH) during initial growth of seedlings. Dry hybrid seeds were treated with ^{60}Co γ rays (50 kR) or 0.01 M MH. Both treatments caused a similar level of growth retardation. Enzyme changes in the seedlings were analysed at the isozyme level taking daily post-treatment samplings over a 6-day period. In 4-day old seedlings the enzyme profile of the control was almost indistinguishable from those of both treated materials, but 9 days after germination the profiles were strikingly different. Irradiation, in general, exerted more severe effects on the enzyme systems than MH-treatment. The striking radiation-induced changes were increased in most arylesterases of the first internode after 5 days, decreased in the pH 7.5 esterases of the shoot after 7 days and increased in some peroxidases, as well as giving the appearance of a trailing peroxidase band. The striking MH-induced changes were retention of activity of the pH 7.5 esterases in the first internode and of one of the malate dehydrogenases in older seedlings. Activity of the enzymes decreased in both control and irradiated materials. The results suggest that the different treatments act on different regulatory systems controlling gene activation and/or repression, resulting in differential alterations of the enzyme pattern. (auth)

14600 MODIFICATION OF THE RADIATION EFFECT ON CATALASE BY SELENIUM. Lohmann, W.; Moss, A. J. Jr. J. Nucl. Med., 7: 878-80(Nov. 1966).

The change in radiosensitivity of catalase in solution by selenium (as Na_2SeO_4) was investigated using a spectrophotometer. The x irradiation dose was 4.5×10^5 R in each case. The protective effect seems to be due to a complex formation between selenium and the enzyme molecule rather than to radical scavenging. (auth)

14601 PEROXIDE HYPOTHESIS IN RADIATION BIOLOGY. Moritz, R. (Geschivulstklinik der Charite, Berlin). Deut. Gesundheitsw., 20: 762-6(Apr. 29, 1965). (In German).

The author reviews experimental findings and theoretical considerations that form the basis of the peroxide hypothesis of radiobiological effects. Evidence quoted indicates that increased concentrations of peroxides in tissues of irradiated animals are only a relatively unimportant, nonspecific reaction that is not essentially involved in the development of radiation injury. The role of peroxides in production of radiation effects is incompletely defined at present. The conclusions from this review make it appear improbable that radiogenic peroxides play an essential role as intermediates between irradiation effects and biological effects. It seems more probable that

vitally important molecules are directly converted into peroxides and thus inactivated directly without an action of an intermediate product. 63 references cited. (BBB)

14602 STUDIES ON EXPERIMENTAL RADIATION INJURY IN MICE BY INTERNAL ^{90}Sr. III. EFFECTS OF INTERNAL ^{90}Sr ON CALCIUM AND PHOSPHORUS METABOLISM IN BONE AND SOME ORGANS. Hayashi, Mitsuaki; Miyao, Noboru (National Inst. of Animal Health, Tokyo). Nat. Inst. Animal Health Quart., 6: 109-18(Summer 1966).

Studies were made in four-week-old mice on the incorporation of ^{45}Ca into femur after intraperitoneal injection of ^{90}Sr, the retention of ^{45}Ca in femur after simultaneous intraperitoneal injection of ^{90}Sr and ^{45}Ca, and the incorporation of ^{32}P into femur and in various phosphorus compounds in the liver and spleen after intraperitoneal injection of ^{90}Sr. Incorporation of ^{45}Ca into femur was decreased after injection of 0.5–2 μCi/g of ^{90}Sr. Retention of ^{45}Ca in the femur was higher than that of controls after simultaneous injection of ^{90}Sr and ^{45}Ca. Incorporation of ^{32}P into femur was reduced after injection of 2 μCi/g of ^{90}Sr. Incorporation of ^{32}P into spleen liver phospholipid and phosphoprotein and the activity of ATPase were markedly increased and incorporation into the mesenteric lymph node and liver moderately increased 10 days after injection of 2 μCi/g of ^{90}Sr, but no changes were seen in incorporation into the heart, lung, and kidney. Only spleen and lymph nodes showed a high ^{32}P uptake 30 days after the injection. On the 10th day following injection of 2 and 1 μCi/g, incorporation of ^{32}P into the spleen DNA was considerably increased. It was also increased in the acid-soluble, phospholipid, and phosphoprotein fractions. (BBB)

14603 ENHANCEMENT OF OXIDATION PRODUCTS OF LIPIDS IN LIVER MITOCHONDRIA OF WHOLE-BODY IRRADIATED RATS. Zicha, B.; Lejsek, K.; Benes, J.; Dienstbier, Z. (Charles Univ., Prague). Experimentia, 22: 712-13(Nov. 15, 1966).

The effects of whole-body x irradiation on the content of oxidation products of lipids in rat liver mitochondria were determined at intervals up to 48 hr after exposure to 1400 R. Mitochondria were isolated from liver samples. Protein was determined by the biuret method and lipid peroxide was measured by the thiobarbituric acid color test (TBA) after aerobic incubation. At zero time after whole-body irradiation the amount of TBA chromogen in mitochondria was elevated and the enhancement was statistically significant up to 6 hr, after which the level returned to normal control values. It was concluded that mitochondria are transiently damaged by irradiation in vivo but are soon reconstituted to reach pre-irradiation levels. (C.H.)

14604 POSITIVE THIOBARBITURIC TEST FOR PEROXIDES IN THE EXTRACT OF IRRADIATED FLAX SEEDS. Sideris, E. G.; Nilan, R. A. (Washington State Univ., Pullman). Contract AT(45-1)-353. Radiat. Bot., 7: 73-4(Feb. 1967). (RLO-353-6).

Qualitative results on the formation of oxidants in flax seeds treated with 60,000 R of ^{60}Co γ irradiation are reported. Thiobarbituric acid, which produces a deep orange color when peroxides are present, was used for detecting the oxidants. The formation of oxidants was indicated by a characteristically deeper orange in extracts of irradiated seeds than those of non-irradiated seeds. The high content of unsaturated fatty acids, especially linoleate, in flax seeds suggests that the compound reacting with thiobarbituric acid is an oxidation product of linoleate. Appearance of a delayed positive color reaction to thiobarbituric acid in the extract of non-irradiated seed is in agreement with the conclusion of Bernheim that the formation of peroxides occurs soon after normal cells are damaged. The relation between fatty acid content of plants and radiosensitivity is discussed. (H.G.D.)

14605 KINETIC ISOTOPE STUDIES ON THE INACTIVATION OF TRANSFORMING DEOXYRIBONUCLEIC ACID, TOBACCO MOSAIC VIRUS, AND ITS NUCLEIC ACID BY ULTRAVIOLET LIGHT. Tao, Mariano; Gordon, Milton P.; Nester, Eugene W. (Univ. of Washington, Seattle). Biochemistry, 5: 4146-52(Dec. 1966).

The effect of solvent on the inactivation of transforming deoxyribonucleic acid (DNA), tobacco mosaic virus, and its nucleic acid by ultraviolet irradiation at 253.7 mμ was investigated. The rate of inactivation of tobacco mosaic virus ribonucleic acid in heavy water was slower than in light water. The ratio of the rate constants, K_{H_2O}/K_{D_2O}, is about 1.9. Ribonucleic acid irradiated in either light or heavy water photoreactivated to the same extent. Irradiation of transforming DNA in either light or heavy water did not affect the rate of inactivation. Based on the observations of the irradiations of pyrimidine derivatives in light and heavy water, it is suggested that the addition of a water molecule to the 5.6 double bond of the pyrimidine ring may be the cause of inactivation of tobacco mosaic virus ribonucleic acid. In the case of transforming DNA, the photochemical reaction leading to inactivation does not appear to be directly caused by reaction with solvent but probably by the photodimerization of the pyrimidine residues. Irradiation of intact tobacco mosaic virus in either light or heavy water exhibited no kinetic isotope effect. Thus inactivation of intact virus may result from a mechanism different from that of the free nucleic acid. (auth)

14606 EXPERIMENTAL STUDY OF THE RADIOACTIVE CONTAMINATION OF SOME CULTIVATED PLANTS BY IRRIGATION WATER. Huguet, Claire; Delas, Jacques; Delmas, Jacques; (and others). Tech. Eau (Brussels), No. 231, 31-42 (Mar. 15, 1966). (In French).

Results are reported from studies on the quantitative relation existing between the application to the soil of long-lived radioisotopes by irrigation water and the level of contamination of the vegetable food products at the limit of accumulation of the radioisotope in the soil. Data are reported for the years 1961 and 1962, the fifth and sixth years of observation. Concentrations of ^{137}Cs and ^{90}Sr in soils, potatoes, lettuce, carrots, cabbage, cabbage flowerets, green beans, spinach, leeks, and tomatoes are tabulated. The results show that the degree of contamination of the plants is lowered from the second to the third year. In the last year the ^{90}Sr begins to appear significantly only in the leafage. (J.S.R.)

14607 TOXICITY OF SERUM FROM IRRADIATED DONORS. Garcia, John; Ervin, Frank R.; Koelling, Robert A. (Harvard Medical School, Boston. Massachusetts General Hospital, Boston). Nature, 213: 682-3(Feb. 18, 1967).

The radiation sickness that many mammals suffer may be due to a circulating by-product of energy absorption with toxin-like effects. When rats drink water flavoured with saccharin and are injected with serum from irradiated donors, they develop an aversion to this fluid. This effect was previously observed in directly irradiated and poisoned animals. (auth)

14608 EFFECTS OF ULTRA-VIOLET MICROBEAM IRRADIATION OF VARIOUS SITES IN HeLa CELLS ON THE SYNTHESIS OF RNA, DNA, AND PROTEIN. Takeda, S.; Naruse, S.; Yatani, R. (Mie Prefectural Univ., Tsu-shi, Japan). Nature, 213: 696-7(Feb. 18, 1967).

An autoradiographic study was carried out on the effects of uv microbeam-irradiation of different cellular sites on the synthesis of RNA, DNA, and protein in a standard HeLa cell line in order to compare the pattern of inhibition in a single cell type. Results showed that the irradiation at one nucleolar or extranucleolar nuclear site rapidly caused inhibition of RNA synthesis, which was partly restored a short time after irradiation. Inhibition of DNA synthesis developed less rapidly and was not restored within the observational period of 12 hours. It was also shown that protein synthesis is resistant to irradiation of any cellular area at the dose used. (UK)

14609 THE REPAIR OF X-RAY DAMAGE TO THE DEOXYRIBONUCLEIC ACID IN MICROCOCCUS RADIODURANS: A STUDY OF THE EXCISION PROCESS. Lett, J. T.; Feldschreiber, P.; Little, J. G.; Steele, Kathleen; Dean, C. J. (Royal Cancer Hospital, London). Proc. Roy. Soc. (London), Ser. B, 167: 184-201 (Feb. 21, 1967).

Following non-lethal anoxic x-irradiation the bacterium Micrococcus radiodurans suffers a delay in deoxyribonucleic acid (DNA) synthesis and during this delay components are released from the cellular DNA into the cytoplasm and into the surrounding culture medium. These events are subsequent to the radiochemical damage suffered by the macromolecular structure of the DNA, which can be detected by physico-chemical means. The rate at which material is released (or excised) from the DNA is independent of the x-ray dose and the kinetics of the process suggest that an enzyme is effecting most the release and that it is present in limiting amounts. Studies of the excision products indicate that the enzyme is an exonuclease. (auth)

14610 TRACE METAL CONTENT OF MOUSE TISSUES AFTER X-IRRADIATION. Yendell, A.; Tupper, R.; Wills, E. D. (St. Bartholomew's Hospital Medical Coll., London). Biochem. J., 102: 23P-4P(Feb. 1967).

The results of some studies on changes in concentration of Fe, Cu, Zn, and Mg in tissues of young mice after a single whole-body dose of 750 rads x-irradiation from a linear accelerator are given. Significant changes in Fe, Cu and Zn concentrations were found in the liver and spleen. No change was found in muscle Cu, but Fe and Zn levels were affected. The lungs showed Fe and Cu changes, while Zn levels remained unaltered. The kidneys showed only an Fe change. Red cells showed little change for all these elements. There were Zn changes in the adrenals

and bone marrow, but not in the thymus. There were small changes in Mg concentration in some tissues. (UK)

14611 PROGRESS IN NUCLEIC ACID RESEARCH AND MOLECULAR BIOLOGY. VOLUME 5. Davidson, J. N.; Cohn, Waldo E. (eds.). New York, Academic Press, 1966. 467p. $16.00.

Topics covered include: biochemistry of D-arabinosyl nucleosides, effects of some chemical mutagens and carcinogens on nucleic acids, nucleic acids in chloroplasts and metabolic DNA, enzymatic alteration of macromolecular structure, hormones and the synthesis and utilization of ribonucleic acids, nucleoside antibiotics, recombination of DNA molecules, chemistry of pseudouridine, and biochemistry of pseudouridine. (M.C.G.)

Ecology

Refer also to abstracts 14550, 14558, and 14590.

14612 (BNWL-280, pp 123-6) MIGRATION OF COLUMBIA RIVER FISH. Watson, D. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The movement of resident Columbia River fish upstream from Hanford reactor outfalls or into a tributary stream was studied. The presence of ^{65}Zn, acquired by fish when downstream from reactor outfalls, served as a radioactive tag. (auth)

14613 (BNWL-280, pp 131-2) COLUMBIA RIVER CHINOOK SALMON SPAWNING NEAR HANFORD. Watson, D. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

A record number of 1768 salmon nests were observed in the section of the Columbia River near the Hanford Project. This is approximately 300 more than the previous high during the past 19 years. (auth)

14614 (BNWL-280, pp 127-30) COLUMNARIS DISEASE IN COLUMBIA RIVER FISHES. Fujihara, M. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Studies of the incidence of Columbia River fishes with antibodies against Chondrococcus columnaris disclosed a single annual cycle apparently related to water temperature and re-exposure of fish to the columnaris organism. Four sampling sites, Bonneville, McNary, Hanford, and Wenatchee, showed a similar pattern of decline during cold water periods and a sharp rise with warmer temperatures and with the presence of columnaris organisms in the water. (auth)

14615 (BNWL-280, pp 103-4) POPULATION CHANGES IN DARKLING BEETLES. Rickard, W. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

A 3 year decline in beetle population on the Hanford Reservation may be related to the concurrent decline in yield of herbaceous plants. (auth)

14616 (BNWL-280, pp 100-1) COMPONENTS OF VARIABILITY IN RADIONUCLIDE ABUNDANCE IN NATURAL ENVIRONMENTS. Eberhardt, L. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Results are reported from preliminary investigations as to the components or sources of variability in radionuclide concentrations in samples from natural environments. Variability due to analytical methods, differences between individual animals, and environmental factors are considered. Preliminary findings suggest a major importance of the environmental aspects. (auth)

14617 (NYO-2579-14) RADIOECOLOGY OF SMALL VERTEBRATE SPECIES UNDER NATURAL ENVIRONMENTS. Progress Report, December 1, 1965-November 30, 1966. (Pittsburgh Univ., Pa. Pymatuning Lab. of Ecology). Contract AT(30-1)-2579. 31p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The ecology of three small mammals, the pocket gopher (Thomomys talpoides), the Unita ground squirrel (Citellus armatus), and the chipmunk (Tamias striatus) was investigated. The purpose of this work was to find a test animal suitable for radiation experiments. Gophers of northeast Wyoming were trapped at various altitudes and census records of populations were kept. Ground squirrels were found at the same altitudinal transect, but it was not possible to obtain accurate population figures because the animals began to enter hibernation in August. The chipmunk occurs from the Atlantic seaboard to Minnesota and census studies were made by a number of investigators. At Pymatuning Laboratory studies on analysis of population numbers and biomass of this mammal are being conducted. Results of all of these studies are presented in the form of tables and graphs. The measurement of thyroid secretory activity of small mammals was undertaken as an indication of total metabolic activity in order to study relative effects of radiation exposure. Animals were injected intraperitoneally with iodine-131-labeled sodium iodide and returned to their natural environment. After 48 hours the animals were recaptured, whole body counted, and returned again. The thyroid was counted separately in vivo. The slopes of whole body counts and thyroid counts were similar, indicating that whole body elimination of iodine-131 was a function of thyroid secretion of the isotope. Iodine-131 retention curves for free-ranging pocket gophers and ground squirrels were examined. It was noted that the weights of adrenal glands were significantly different at different elevations. The adrenal weights and iodine-131 curves tended to substantiate each other and offered correlative evidence as to the relative stress demands on the pocket gopher and ground squirrel at different elevations. (H.L.W.)

14618 SECRETION OF ^{131}I INTO MILK UNDER CONDITIONS OF ENVIRONMENTAL CONTAMINATION OF PASTURE. Sasser, L. B.; Hawley, C. A. Jr. (Colorado State Univ., Fort Collins). J. Dairy Sci., 49: 1505-10 (Dec. 1966).

A series of studies was conducted to investigate the steps of ^{131}I transfer in the air-vegetation-cow-milk-human food chain. Uptake and secretion of ^{131}I into the milk of dairy cows confined to a ^{131}I-contaminated pasture were studied. The pasture was contaminated by releasing 1 Ci of ^{131}I, in the form of iodide gas, into the atmosphere over the pasture. This procedure simulated the release of ^{131}I, in the I_2 form, from a nuclear reactor accident. Six Holstein cows were allowed to graze the contaminated pasture. Grass samples were collected daily, along with milk, urine, and feces samples, and analyzed for gross γ activity. Pasture activities declined daily from 1450 to 270 pCi of ^{131}I increased rapidly and peaked in 2 to 3 days. There were 4-fold variations among cows in the ^{131}I levels of their milk, and the percentage of the daily ingested ^{131}I levels paralleled milk, but the feces showed little variation between cows. When the cows were removed from the contaminated pasture, milk activity declined with an effective half time of less than 1 day for the first 3 days, but then declined at a slower rate. (BBB)

14619 ACTIVITY AND DENSITY OF OLD-FIELD ANTS OF THE SAVANNAH RIVER PLANT, SOUTH CAROLINA. Van Pelt, Arnold F. (Greensboro Coll., N. C.). J. Elisha Mitchell Sci. Soc., 82: 35-43 (May 1966).

An intensive study is being made of abandoned crop fields on the AEC Savannah River Plant, Aiken and Barnwell counties, South Carolina. Successions of plants, as well as of animals, over a 12-yr period have been recorded, and certain aspects of the inorganic and organic materials of the field have been analyzed. All of these changes are being related to the energy flow of the community. To aid in understanding the total field community, the activity and density of the ants were studied. A list is provided of 52 species or subspecies representing 27 genera of Formicidae collected on the AEC Savannah River Plant area. It is estimated that further intensive collection should yield 10 to 20 additional species. Field surveys showed that the number of craters of Dorymyrmex pyromicus increased during summer months due to expanding colony sizes and increase in the number of colonies. The greatest density of Dorymyrmex craters occurred in an area covered with discrete Andropogon virginicus clumps and aster but few other herbs or grasses. Optimum temperature for above-ground activity of Dorymyrmex was 40°C, while temperature above 57°C caused a diminution or cessation of activity. Three methods used to estimate the number of workers in a Dorymyrmex crater yielded values of 1500 to 2500 ants per crater. (BBB)

Genetics and Cytogenetics

Refer also to abstracts 14669, 14766, 14767, 14774, and 14775.

14620 RADIATION-INDUCED GENETIC CHANGES. Stevenson, Alan C. (Medical Research Council Population Genetic Research Unit, Oxford). Sci. Basis Med., Ann. Rev., 234-49 (1964).

The following topics are reviewed: radiation dose-mutation induction relations, evidence for the occurrence of radiation-induced mutation in man, the nature of spontaneous and radiation-induced mutations, fate of mutations in populations, and approaches to estimating the effects of mutation on future generations. Before consideration of the effects of increased mutation on man, it is necessary to have a model of the gene pool and the part played in maintaining relative gene frequencies within it by mutation and selection. It is suggested that it is not now possible to arrive at any quantitative estimate of radiation genetic damage to man. It is extremely difficult to arrive at a plausible mean figure for all single gene harmful mutations of the proportion which arise in the parental generation but on average it may be only about 1 in 20. If the mutation rate for chromosomal anomalies is doubled in one generation, there should be one affected in the first generation

offspring for each fresh mutation and the frequency of the appropriate harmful traits would be doubled in the first generation offspring, and thereafter as they are virtually lethal the frequency would revert to the preceding level. Similarly, if the mutation rate is permanently doubled, the frequency of chromosomal anomalies would be permanently doubled. In the case of harmful single gene traits, however, the situation is much more complex. After a doubling of the mutation rate in one generation, harmful traits due to heterozygote expression of mutations would be expected to be doubled in the immediate offspring and thereafter the traits would decrease in frequency to the preceding level in a few generations, as the genes were lost to the population by selection against the trait bearers. If it were possible to establish an overall relation between radiation dose absorbed and mutations induced for each of chromosomal or gene mutations, it should be possible to predict future frequencies of traits of this type. Estimates of this type can only be based on traits which can be counted in the population, are determined by single genes, and where the equilibrium trait frequency is directly mutation-rate dependent. This restricts the estimate in man to those rare genes which determine harmful traits. However, there is no doubt that any increase in mutation is harmful and possible damage must be prevented because it cannot be detected directly. A few years ago a relation between small medical diagnostic exposures in utero and childhood leukemia seemed impossible in the light of experimental knowledge. Now it would seem possible since a parallel degree of radiosensitivity in germ cells was overlooked. (BBB)

14621 GENETICS AGAINST PESTS. Laven, Hannes (Univ., Mainz). Bild Wiss., 6: 447-53(June 1966). (In German).

The resistance of heath damaging insets against chemical agents is increasing constantly and with greater and greater frequency. In 1945 this was noted with Danish houseflies for the first time. By 1950 the resistance of 11 different types of disease-carrying insects had been established. There were 81 types by 1962, by now there probably are 100 types. At first it was believed that this resistance was due to acquired tolerance but it was later found to be based on genetic biochemical differences. New genetic methods to attack these insects are needed more and more imperatively. A very effective method for inflicting genetic injury on pests is the procedure of producing infertile males by irradiation. This procedure has been used effectively against the melon fly (Dacus cucurbitae) and screw worm fly (Callitroga hominivorax). This type of procedure requires that the life cycle and habits of the insect pest be known in great detail. Not only the generation time and the number of individuals naturally present, but also the flying range of the sexes, the sex ratio, and the mating areas must be known. The mating frequency also will be a factor in determining how many offspring will be produced. (BBB)

14622 CYTOGENETIC STUDY ON THE EFFECT OF X IRRADIATION. I. RADIATION-INDUCED CHROMOSOME ABERRATIONS IN THE GENERATION CYCLE OF THE BONE MARROW CELLS OF THE RAT. Nakao, Kiku; Kinugasa, Keiji (Tokyo Univ.). Igaku to Seibutsugaku, 70: 326-31(June 10, 1965). (In Japanese).

Chromosome aberrations induced in bone marrow cells by x irradiation of rats were investigated. Female Wistar rats, weighing 120-150 g, were irradiated with 100-R doses. At various intervals (3, 6, 10, 20, 30, 72 hr) after irradiation femoral bone marrow cells were examined. The frequency of diploid cells in control group was 92% and in the irradiated groups 83 to 87%. At 20 hr after irradiation the percentage of diploid cells decreased to 80%. The number of hyperdiploid cells (43 to 44 chromosomes) was increased at 3-10 hr after irradiation. However, at 20-72 hr after irradiation the hypodiploid cells (40-41 chromosomes) were increased. At 3 and 6 hr after irradiation 33% and 22% of cells with chromosome aberrations were demonstrated. These aberrations included chromatid gaps, chromatid breaks, and isochromatid gaps. However, no aberrations were observed in the control group Some fragments and dicentric ring chromosomes were also observed in irradiated groups at 10 hr after irradiation. The hypodiploid (40-41 chromosome) cells showed max frequency after irradiation at the G-1 stage. In general, when G-1 stage cells were irradiated, DNA synthesis was severely inhibited. After 150-rad irradiation DNA synthesis was inhibited ~50%. (BBB)

14623 THE FATE OF X-RAY-INDUCED CHROMOSOMAL REARRANGEMENTS INTRODUCED INTO LABORATORY POPULATIONS OF DROSOPHILA MELANOGASTER. Vann, Edwin (Wayne State Univ., Detroit). Amer. Natur., 100: 425-49(Sept-Oct, 1966).

Highly inbred male flies were x irradiated with 5000-R doses to induce various types of chromosome structural rearrangements in the sperm. Thirty chromosomal rearrangements were subsequently recovered and cytologically identified. Members of each culture that contained a newly-induced rearrangement (one of either 15 paracentric, or 9 pericentric inversions or 6 translocations) were mated to nonirradiated members of other inbred lines to initiate populations that initially contained known frequencies of a specific rearrangement and that also possessed varying degrees of genic dissimilarity between the chromosomes of each pair of founding lines. After 8 or 9 generations, larval salivary gland chromosomes from each population were examined to determine the frequency of structural heterozygotes within the populations after having been subjected to the effects of natural selection. Results showed that paracentric inversions were considerably more able to maintain structurally polymorphic populations than either pericentric inversions or translocations. From the observed frequencies of the paracentric inversions in populations it was shown that: (1) individuals structurally heterozygous for a 2-break paracentric inversion suffered from an average selective disadvantage of 0.35, relative to noninversion homozygotes, due to the breakage of the chromosomes; this disadvantage was seen to be counteracted to varying degrees by the amount of genic heterozygosity included within the inverted segment; (2) there was a curvilinear relation between the length of the inverted segment and structural heterozygote fitness; this relation likewise varied with the amount of genic heterozygosity included within the inverted segment; (3) individuals structurally heterozygous for chromosomes of unrelated origins maintained almost 50% more genic hybridity (per small chromosome segment) than did those whose chromosomes came from the same mass culture of flies; and (4) from the relative success of the paracentric inversions in maintaining structurally polymorphic populations, the genes contributing to fitness heterosis are well-scattered among the chromosome arms of this species. (BBB)

14624 SELECTION PRESSURE IN MAMMALIAN CELL POPULATIONS. Ford, C. E. (Medical Research Council, Harwell, Eng.). Symp. Int. Soc. Cell Biol., 3: 27-45(1964).

Cytogenetic studies of irradiated populations of mammalian somatic cells are reviewed, and evidence for differential proliferation of distinct karyotypic components in mammalian cell populations generally is discussed. A mouse that had survived a normally lethal dose of x rays in chemical protection experiments provided bone marrow which was examined cytologically and part used for injection into 5 irradiated host mice. Three clones of cells with clearly distinct karyotypes were identified in the bone marrow and spleen of the original animal. Between 32 and 49 days after irradiation, over 90% of all the mitoses examined in the recipients were members of 1 of the 3 clones identified in the donor. Thus, different, karyotypically distinct, clones of cells derived from irradiated progenitors have different capacities to proliferate in their natural in vivo environment. This conclusion is supported by other observations, which are described, involving transplantation of bone marrow cells, in a serial manner into a succession of irradiated hosts. By the fourth transplant generation the descendants of the original donor bone marrow cells had disappeared and a prominent clone of cells characterized by two distinctive marker chromosomes was present. This clone was overwhelmingly dominant in the bone marrow and spleen for 3 transplant generations. Furthermore, since it was present in all the animals of the fourth generation that were examined it must have arisen from an irradiated cell of the third generation host, if not an earlier one. This clone evidently had a considerable selective advantage over the descendants of the surviving cells in its successive irradiated hosts. This experience of the cytogenetics of irradiated somatic tissues of the mouse demonstrates that clones of cells defined by unique marker chromosomes can be identified and shown to have differential capacities to proliferate. Different karyotypic classes contribute equally to the growth of mammalian cell populations: there is selection among them. In normal somatic tissues selection is said to be conservative, in irradiated somatic tissues conservative and competitive, and in neoplastic tissues and cultured cell lines progressive. (BBB)

14625 MUTANTS AND LINKAGE GROUPS OF THE SCREW-WORM FLY. LaChance, Leo E. (State Univ. Station, Fargo, N. D.); Dawkins, Charles; Hopkins, D. E. J. Econ. Entomol., 59: 1493-9(Dec. 1966).

Some radioinduced visible mutations in the screw-worm fly, Cochliomyia hominivorax, are described. In a program to derive mutant strains, 3 techniques were used to find flies with aberrant phenotypes which could be investigated further: (1) microscopic examination of vast numbers of untreated flies (general scanning); (2) treatment of adult flies with γ radiation or tretamine over a wide range of substerilizing doses and close examination of their F_1 progeny for inherited variations; and (3) an inbreeding program in which a single pair of flies was used to produce a group of progeny. The F_1 (brothers and sisters) were, in turn, inbred to produce the F_2 generation. Fifteen genetically marked strains were derived; 13 were recessive mutations and were established

as pure breeding stocks. Both dominant mutations are lethal in the homozygous condition and could not be established as a pure breeding strain. The mutation, Brc (black R-cell), was associated with a chromosome translocation (position effect). The Brc: # Blackened R-cell mutant was found in progeny from irradiated parents of a wild-type strain. It is a wing mutant in which the R-cell is blackened by dense pigmentation, and is a dominant mutation associated with a reciprocal translocation; the homozygous condition is lethal. The sh: shortened r-m mutant was among the progeny from irradiated parents of a wild-type lab strain. It is a wing mutation in which the r-m vein is shortened and without its characteristic bend. In all males the allele is penetrant and uniformly expressed; in some homozygous females, the character is indistinct. This report summarizes the data on the pure breeding strains with regard to heritability of the character, viability of the mutant genotypes in the preimaginal stages, and the linkage relations. (BBB)

14626 PERIPHERAL BLOOD CULTURES IN THE STUDY OF ALTERATIONS OF THE HUMAN KARYOTYPE FOLLOWING IRRADIATION AND THE ADMINISTRATION OF CYTOSTATICS. **Pricajan, Sidonia; Cirnu, Liliana; Aldea, Gabriela; Rosin, S.; Caratzali, A. (Oncology Inst., Bucharest). Rum. Med. Rev., 9: 60-6(Oct.-Dec. 1965).**

The effect of ionizing radiation and cytostatic drugs on human chromosomes was analyzed by use of phytohemagglutinin-stimulated cultures of peripheral leukocytes. Cultures were prepared for 4 control subjects, 6 subjects occupationally exposed to radiation, 1 oral cancer patient x irradiated locally with 10,000 R, a goiter patient who received ^{131}I, and 2 cancer cases treated with thio-TEPA and triethylenemelamine. Two nurses exposed to radiation for over 20 yr in the course of work in a radiology department showed chromosome anomalies. In one case, 20% of the cells examined showed 2 supernumerary chromosomes. In the other case one metaphase out of the 16 examined revealed 59 chromosomes. Chromosome anomalies were also noted in the 2 drug-treated patients. The karyotypes for each of these subjects are illustrated. (BBB)

14627 INTERNATIONAL COOPERATION IN MUTATION BREEDING RESEARCH. **Sigurbjoernsson, Bjoern (IAEA, Vienna). Qualitas Plant. Mater. Veg., 13: 389-94(Aug. 15, 1966).**

Cooperative studies being carried out under unified control in various nations for using ionizing radiations, neutrons, and other mutational agents for crop improvement are briefly discussed. The Joint FAO/IAEA Division of Atomic Energy in Agriculture is conducting several internationally coordinated programs of research in the fields of mutation research, insect eradication, fertilizer efficiency studies, and food preservation. Participating scientists in each of these programs work on the same general problems and coordinate their approach to solving them. This is done in some cases by having all participants run identical field experiments, in other cases by the distribution of specific tasks or by combined efforts to solve certain problems as appropriate. Once a year the participants in these programs meet to report on their research activities and to coordinate their research programs for the ensuing year. The oldest of these programs, in operation for 3 yr, deals with studies on the efficient use of fertilizers in rice and maize cultivation using isotopic tracer techniques. Two international plant breeding research programs include one which deals with research on induced mutations in rice breeding, being carried out by institutes in 7 southeast Asian countries. The second deals with research on methods of production and use of induced mutations in plant breeding, with 14 institutes in 11 countries of Europe, America, and Asia participating. Planned activities concern the use of neutrons in seed irradiation and the screening and testing of mutant collections in various countries. (BBB)

14628 ANTENNAPEDIA (SS^{Anp}), AN HOMOEOTIC MUTANT OF DROSOPHILA HYDEI STURTEVANT. **Gloor, H.; Kobel, H. R. (Rijksuniversiteit, Leiden). Rev. Suisse Zool., 73: 229-52(May 1966). (In German).**

A new mutant of the spineless-aristapedia type in D. hydei is described. It was produced by irradiation of the male flies with a 10,000-R dose of 60-kv x rays delivered at a dose rate of 380 R/min. It is designated as Anp (Antennapedia). Anp is variable in its expression, is dominant, lethal when homozygous, and inseparable from an inverted transposition in the second chromosome. Expression and penetrance of the mutant increase with higher temperatures, while at the same time viability decreases. The phenotypic effect of Anp consists, apart from various deformations of head parts, of the formation of leg-like structures on, or instead of, the antenna, leading in extreme cases to the differentiation of a nearly complete leg. A trochanter was never observed, but structures resembling a coxa may originate between antenna and eye. The homoeotic leg has in all cases the appearance of a mesothoracic leg. The mechanism of homoeotic transformation is discussed in terms of divergent gradients of growth, competing tendencies of differentiation, and prepattern formation. (BBB)

14629 ULTRAVIOLET IRRADIATION AND MUTATION OF NORMAL CELLS. **Lin, Jen-Kung; Tung, Ta-Cheng (National Taiwan Univ., Republic of China). T'ai-wan I Hsueh Hui Tsa Chih, 62: 484-9(June 28, 1963). (In Chinese).**

The genetic information in cells is transformed through the base sequence of DNA, and when the normal base sequence of DNA is changed by various agents, cell mutation occurs. When the pyrimidine nucleus absorbs uv energy, some structural modification may result, including hydration of cytosine and formation of thymine dimers. When thymine dinucleotide or thymine polynucleotide is irradiated with 260 to 280 mμ uv light, thymine dimerization occurs. However, if they are irradiated with 230 to 250 mμ uv again, the dimer decomposes. Ultraviolet irradiation in biological systems may result in thymine dimerization in the same strand of DNA. When large doses of uv are used to irradiate DNA, the backbone linkages of DNA strands may be broken. If, during the replication of new DNA when the double stranded helix is separated, the double strand DNA forms interchain thymine dimers, then the double strand DNA may not readily separate. The replication of new DNA is inhibited and the cell may die. Some bacteria contain an enzyme which can split the thymine dimer into monomers so that they are resistant to uv irradiation. (BBB)

14630 DEUTERIUM OXIDE: DIRECT ACTION ON SYMPATHETIC GANGLIA ISOLATED IN CULTURE. **Murray, Margaret R.; Benitez, Helena H. (Columbia Univ., New York). Science, 155: 1021-4(Feb. 24, 1967).**

Immature ganglia from chicks and rodents were maintained as organized, developing cultures for 2 months or more, during which time they were continuously exposed to deuterium oxide in their medium. Observations of the living cell communities with the light microscope indicated that deuteration within viable limits (up to 25 percent) accelerates and increases the growth of sympathetic neurons and favors their repeated subdivision as a very large size is attained, thus inducing them to recapitulate cyclically the early stages of neurogenesis. Living deuterated cells appear more opaque and heteromerous than control neurons; furthermore, electron micrographs reveal an unusual abundance of granular and fibrillar elements in the nuclei of both neurons and supporting cells. Sheaves of complexly organized fibrillar components appear in the neuronal perikaryon; and ribosomes, Golgi elements, and microtubules are conspicuously numerous. Both fine structure and function of these ganglia therefore appear to have been modified directly by action of the deuterium isotope. (auth)

14631 A MATHEMATICAL ANALYSIS OF THE TRANSFER OF FISSION PRODUCTS TO COWS' MILK. **Garner, R. J. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Health Phys., 13: 205-12(Feb. 1967).**

A model was developed that allows mathematical treatment of the elimination of ingested fission products in milk. Equations are derived from the available experimental data that are used to predict the behaviour of a number of parent-daughter mixtures. (auth)

14632 RETENTION AND FATE OF INHALED PLUTONIUM DIOXIDE IN DOGS. **Morrow, P. E.; Gibb, F. R.; Davies, H.; Mitola, J.; Wood, D.; Wraight, N.; Campbell, H. S. (Univ. of Rochester, N. Y.). Health Phys., 13: 113-33(Feb. 1967).**

An inhalation study of plutonium dioxide in twenty-two dogs following single exposures is described. The study embraced the clearance of PuO_2 dust from the lungs and its fate. The pulmonary clearance process, computed by several methods including in vivo counting, can be described as a bi-phasic exponential with mean biological half-times of ~1 and 400 days, respectively. By excluding the first postexposure week, the lung clearance can also be approximated by the power function $t^{-0.22}$. The tissue distribution of plutonium in animals sacrificed between 16 and 468 days after exposure is described. The bronchial lymph nodes and the lungs had the highest plutonium concentration and, on the average, accounted for 95 per cent of the body burden. The principal pathological effects noted were associated with these tissues. Few extrapulmonary tissues, except the gonads and lymph nodes, appeared to have received important radiation doses. The absorption of plutonium averaged 3.5 percent of the PuO_2 deposited. A disproportionate part of the absorption appeared to have occurred shortly after exposure. The report also describes the elimination kinetics of plutonium and discusses some problems in interpreting excretion data. (auth)

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Refer also to abstracts 14154, 14305, 14550, 14558, 14559, 14590, 14616, 14667, 15028, and 15215.

14633 (BNWL-280, pp 33-4) APPLICATIONS OF THERMOLUMINESCENCE DOSIMETRY. Watson, C. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Thermoluminescence dosimetry was used for in vivo gamma dosimetry of ingested ^{137}Cs in sheep. The sheep data substantiate the use of the whole body as the critical organ for ^{137}Cs ingestion. (auth)

14634 (BNWL-280, pp 101-3) ^{137}Cs IN WINTER AND SUMMER ANNUALS OF A DESERT STEPPE ENVIRONMENT. Rickard, W. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Radioactive debris is deposited on the earth's vegetative cover from the atmosphere under dry conditions but more is brought down with precipitation. Annual plants of arid and semi-arid regions can be used as biological indicators of yearly or subyearly deposition of ^{137}Cs. (auth)

14635 (CEA-R-3104) DECONTAMINATION DES INSTALLATIONS DE L'ATELIER PILOTE DE TRAITEMENT DES COMBUSTIBLES IRRADIES. (Decontamination of Installations in the Irradiated Fuel Processing Pilot-Plant). Cohendy, Gerard; Ribes, Claude; Niezborala, Fernand; Le Bouhellec, Joeel (Commissariat a l'Energie Atomique, Chusclan (France). Centre de Production de Plutonium de Marcoule). Oct. 1966. 28p. (In French). Dep. mn.

Procedures used in the decontamination of 9 cells of the irradiated fuel processing pilot plant are described. The operations resulted in internal decontamination of circuits and external decontamination of cell apparatus and the cells themselves. The decontaminating agents used for the rinsings were principally nitric acid and sodium carbonate, sometimes mixed with tartaric acid. Sodium fluoride in nitric acid solution and EDTA in alkaline solution. The decontaminating effect of sodium fluoride on zirconium and of EDTA on ruthenium and cerium was verified. (J.S.R.)

14636 ^{40}K: SERIAL DETERMINATIONS IN INFANTS. Maresh, Marion; Groome, David S. (Univ. of Colorado, Denver). Pediatrics, 38: 642-6(Oct. 1966).

A study was made of the feasibility of using a whole-body counter for monitoring ^{40}K in infants. After 6 months of experimenting with the position of detector and child and means of monitoring the sleeping infant, most of the difficulties were overcome. The counting shield was a $2.4 \times 2.4 \times 2.4$ m room with 12.7 cm steel walls lined with 3 mm lead. The child was quiescent in a prone position on a tight canvas frame supported from the walls of the room. A 10.2×22.9 cm NaI (Tl) detector utilizing 4 photomultiplier tubes was located under the canvas with the position dependent upon the height and weight of the child. Monitoring of the infant was done by closed circuit television and intercom. Standard procedure was to examine the quiescent infant for four 10-min intervals followed by a 40-min background measurement. No attempts were made to calculate lean body mass for the subjects studied from the ^{40}K data, but K levels were graphed from ^{40}K measurements for the subjects and compared with the chemical determinations of K in the literature. The data from ^{40}K measurements in the first year of life were essentially linear and the coefficient of correlation of 0.94 produced a straight line that had its x : y intercept near zero. These preliminary data describe longitudinally the changes in the body composition of the baby as he grows through the first year of life. (BBB)

14637 A COMPARISON OF TLD AND FILM FOR PERSONNEL DOSIMETRY. Suntharalingam, N.; Cameron, John R. (Univ. of Wisconsin, Madison). Health Phys., 12: 1595-9(Nov. 1966).

The film badge is today the most widely used personnel monitoring device for want of a more reliable and accurate system. Recent evaluations of the performance of the available commercial film badge services report a wide variation in both the accuracy and consistency of the reported exposures. The best accuracy that one can obtain for gamma and x radiation appears to be −50 to +200 per cent. This paper reports the feasibility of using the thermoluminescence of single crystals of LiF (TLD-100) to measure exposure levels of gamma and x radiation encountered in the personnel dosimetry range. LiF single crystals in lucite capsules were attached to film badge holders and given known test exposures from gamma and x-ray sources and mixtures of these radiations. The performance of the TLD system is compared with the measured values reported by the film badge suppliers. The overall accuracy of the TLD system is about ±30 per cent for gamma and x-ray energies above 25 keV effective. (auth)

14638 PATIENT PROTECTION IN DENTAL ROENTGENOLOGY. Fischman, Stuart L.; Dunning, James M. Dent. Progr., 3: 28-30(Oct. 1962).

A shield was designed to reduce total-body and gonadal irradiation of patients during dental x-ray procedures. The shield is of lead-impregnated rubber, affording the equivalent protection of 0.6 mm of lead. The framework is of metal rod $\frac{1}{4}$ inches in diameter. A detachable, flexible collar is fastened at the neckline in such a way as to be easily adjustable. No straps are required to hold the shield in position. The lower part of the shield is curved so as to intercept secondary x rays from the patient's chin over a wider angle and so as to protect the patient's gonads without extending past them. The inward curve permits the patient's arm to be carried forward to hold dental films in the mouth, should this be necessary. The weight of the shield is 7.5 lb. To evaluate the effectiveness of this shield for patient protection, dosimetric films were placed at representative positions on the outer surface of the shield. Duplicate films were placed at corresponding positions on the internal, or patient, side of the shield. The shield was used during the routine dental surveys of patients. It was established that the shield did reduce radiation to the patient. The amount of reduction for the most critical areas (those near the gonadal region) was 99 to 100%. Reduction of 100% means that radiation to the underside of the shield was less than 0.01 mR for a total of 30 to 40 exposures. (Incident radiation averaged 5.6 mR for each exposure.) When used with patients during the first trimester of pregnancy, the shield offers a means of minimizing irradiation of the fetus. When many persons are given routine dental surveys (e.g., dental-school clinics, university health clinics, military facilities), the shield can make an important contribution to public health by reducing the over-all gonadal x-ray exposure of the population. (auth)

14639 THE DENTIST'S POSITION IN RADIATION HYGIENE. Budowsky, Jack (Columbia Univ., New York). N. Y. State Dent. J., 32: 252-8(June-July 1966).

An assessment is made of radiation exposure in dental radiography in comparison with other sources of exposure, and recommendations are made whereby the contribution of dental procedures to the total dose can be minimized. It is apparent that 4 times more radiation results from fallout than from one full mouth series. Some figures for the radiation exposure doses during medical procedures are presented. Present dose levels from background, medical, and other sources are 8000 mR, and only a maximum of 15 mR can be attributed to dentistry. This is equivalent to less than $\frac{1}{500}$ of the total dose to man. It is concluded that radiation doses delivered during dental procedures are infinitesimally small when compared to either individual dosages in specific medical procedures or many of the other contributors to the gonadal doses such as cosmic rays or radionuclides in the soil. (TSS)

14640 RADIONUCLIDES IN MAN FROM NUCLEAR TESTS. Kulp, J. Laurence (Columbia Univ., New York). pp 247-84 of Radioactive Fallout, Soils, Plants, Foods, Man. Fowler, Eric B. (ed.). Amsterdam, Elsevier, 1965.

The following topics are reviewed: production and worldwide distribution of nuclear debris; uptake of radiostrontium by plants, plant-soil Sr relations, and discrimination factors; internal dose to humans from radionuclides and contributions of this dose to somatic and genetic effects; and estimates of fallout levels from a 6000-Mt thermonuclear war. The results of determination of the stratospheric inventory of fission products, i.e., the fraction of ^{90}Sr and ^{137}Cs taken up directly from rain, and new measurements of the concentration of ^{90}Sr in human bone made possible a more accurate prediction of the future radiation doses from these isotopes to the world population. It is concluded that the U. S. diet has passed its peak concentration of ^{90}Sr and ^{137}Cs, that ^{90}Sr probably will remain the largest contributor to the radiation dose to an individual, and that ^{137}Cs measurement can be used to monitor ^{90}Sr in milk in emergency situations. These results also suggest that in the event of large-scale nuclear warfare, the general radioactive contamination would not preclude the existence of large populations if short-time (6 to 12 months) survival were possible. (BBB)

14641 ADMINISTRATIVE EXPERIENCE WITH DECONTAMINATION OF VACATED RADIATION INSTALLATIONS. Kleinfeld, Morris; Abrahams, Albert (New York State Dept. of Labor, N. Y.). Ind. Hyg. Rev., 6: 3-15(Dec. 1964).

A study was made of 11 installations in New York contaminated with radioactive materials, and of means for decontaminating them. The highest level of contamination was found in radium-producing installations, and the lowest level was found in research laboratories. The reasons for the more severe contamination in the radium-producing industry are cited. A good correlation was found between the gaseous radon generated from radium sources

and deposited radon daughter products. There was no correlation between airborne and surface radioactive contamination for other isotopes, supporting the findings of previous investigators. (TSS)

14642 HOW CAN THE DEPTH EFFECT OF GAMMA IRRADIATION BE INFLUENCED? Schipper, P. (Siemens-Reiniger-Werke A. G., Erlangen, Ger.). Strahlentherapie, 126: 514-8 (Apr. 1965). (In German).

All of the advantages of high voltage radiation, such as small volume dose and negligible absorption differences between muscle and bone tissue and surface dose, can be obtained when ^{60}Co or ^{137}Cs is used as a radiation source. With Cs, if the electrons produced are diverted magnetically so that they do not reach the body the surface dose can be reduced by ~40%. Under half depth therapy conditions using ^{137}Cs, greater volume doses can be attained compared with 90 to 120 kV generators. In spite of the use of shielding materials with high atomic and specific weights, they are relatively bulky. In ^{60}Co equipment they must be at least 26 cm thick because of the greater half value thickness of the radiation material, as compared with Cs equipment that requires 14 cm thickness. Both types of sources are suitable for depth and half depth therapy, but Co is best for the former, and Cs is best for the latter type of therapy. (BBB)

14643 PROBLEMS OF RADIOACTIVE CONTAMINATION IN THE SPHERE OF NUTRITION IN VIEW OF ATOMIC TECHNICAL DEVELOPMENTS. A CONTRIBUTION TO THE DISCUSSION OF RISKS, CONTROLS, AND PROTECTION POSSIBILITIES. VI. RADIATIONS AND NUCLEAR FISSION. 5. RADIOACTIVITY FROM ATOMIC INSTALLATIONS AND THE SPHERE OF NUTRITION. Brobecker, Clarisse. Vitalstoffe Zivilisationskrankh., 9: 19-23(Feb. 1964). (In German).

The factors that should be considered in locating and establishing an atomic installation are discussed. Recommendations of the AEC for population densities in the vicinity of water-cooled reactors of various capacities from 10 to 1500 Mw-hr are listed. The recommended population-free zone ranges from 0.2 to 1.4 km, and the nearest distance to a major population center ranges from 1.1 to 28.4 km. The type, amount, and removal of radioactivity in effluents by fixation, fluid, outflow, and stock disposal are considered for several atomic energy installations throughout the world. The greatest amounts are fixed or are carried away by large river flows or in ground waters. Average accumulation factors for various elements by algae, invertebrates, and vertebrates in sea water are listed. Contamination of the Columbia River in the vicinity of the Hanford plant is discussed. Current recommendations for the maximum permissible concentrations for discharge of radioisotopes into the sea and for radioactive emissions from nuclear-propelled ships are compiled for several radioisotopes. Irradiation of tissues and organs from environmental radiation is listed. (TSS)

14644 PROBLEMS OF RADIOACTIVE CONTAMINATION IN THE SPHERE OF NUTRITION OCCASIONED BY TECHNICAL ATOMIC DEVELOPMENTS. A CONTRIBUTION TO THE DISCUSSION OF RISKS, CONTROL, AND PROTECTION POSSIBILITIES. Herbst, Willy (Univ., Freiburg i. B.). Vitalstoffe Zivilisationskrankh., 8: 215-18(Oct, 1963). (In German).

Control of radioactive contamination of foodstuffs is reviewed. The health hazards from incorporated radioactive materials for children and adults are briefly compared in connection with ingestion and absorption of contaminated foodstuffs. In addition to other sources of contamination, the production of ^{60}Co radiation sources, which approaches 10^6 Ci annually represents a current hazard to contamination of the environment. The contamination hazard from fuel production is estimated. Factors affecting concentrations of radioactivity in grass, beef, and milk are considered. (TSS)

14645 TRANSPORT MECHANISMS INFLUENCING ^{90}Sr LEVELS IN MILK. Shumway, Robert H. (United Electro-Dynamics, Inc., Alexandria, Va.). pp 180-203 of Radioactive Fallout, Soils, Plants, Foods, Man. Fowler, Eric B. (ed.). Amsterdam, Elsevier, 1965.

Five years of data from the raw milk sampling network were used to derive a model representing the mechanisms involving the movement of ^{90}Sr from deposition on the plant to incorporation into the milk. Using variables derived from experimental observations, predictions are made for the levels to be expected in milk for each station during the spring and summer of 1962. An attempt is made to document the validity of each assumption made in the chain of reasoning. Current estimates place the expected ^{90}Sr deposition at from 0 to 20% less than in 1959. Strontium-90 content in milk at the five stations were averaged to arrive at average observed and predicted levels at the national level. The observed milk levels are shown along with the levels predicted by the AEC and PHS models. The AEC model tends to smooth out the peaks more and to predict higher peaks for the spring. The AEC figures give an average ^{90}Sr of 11 $\mu\mu$Ci/liter. However, if the fallout deposition should be twice what is expected in every station, the PHS model predicts an average ^{90}Sr value of 15 $\mu\mu$Ci/liter in the U. S. milk supply for 1962. Then, on the basis of fallout deposition predictions and transport assumptions, it becomes possible to predict milk levels for any given future time period in segments of the country where the required measurements are available. This leads to a much better estimate of the average yearly bone marrow dose in any region. (BBB)

14646 APPLICATION OF COMPUTERS TO RADIATION PROTECTION PROBLEMS. Cipperley, Foster V. (Atomic Energy Commission, Idaho Falls, Idaho). Health Phys., 12: 1601-8(Nov. 1966). (TID-22230).

The use of computers and peripheral data processing equipment in the health professions is rapidly increasing. Some uses of automatic data processing in the medical field are cited, and methods of utilizing automatic data processing are presented for the normal operation of the health and safety programs, the rapid evaluation of dosimetric and analytical data in emergency situations, and for all types of problem-solving entailed in the performance of the various research programs at the National Reactor Testing Station. (auth)

14647 AN EVALUATION OF AN EQUATION WHICH ESTIMATES PERCENTAGE DEPTH DOSE FOR ^{60}Co TELETHERAPY. Schaeflein, J. W.; Neblett, D. L.; Sterling, T. D.; Cember, H. (Univ. of Cincinnati). Health Phys., 12: 1617-20(Nov. 1966).

An equation has been developed for dose distributions that can be used in computer programs and eliminates the need for individual isodose charts. This equation has been found useful, subject to some error at the surface, the field perimeter, and in the corners. Errors also occur at points of very low dose, but these are not considered important in radiotherapy. (C.O.)

14648 ^{90}Sr IN MILK IN GREECE FOR THE PERIOD 1962-1964. Douvoyiannis, I.; Mimikos, N. (Democritus Nuclear Research Center, Athens). Health Phys., 12: 1620-4(Nov. 1966).

Results of strontium-90 monitoring are analyzed on the basis of season, precipitation, and time of nuclear detonations. The maximum concentration of strontium-90 per g of calcium is well below the maximum permissible concentration. (C.O.)

14649 NEW YORK CITY RADIOGRAPHIC CONE LABELS. Blatz, Hanson; Eure, John A. (Office of Radiation Control, New York). Health Phys., 12: 1630-2(Nov. 1966).

As an aid in reducing x-ray exposure of patients, a classification system for the various radiographic cones has been developed. A labeling method for identifying each type and giving information on the maximum tube-to-film distance for the film size is described. (C.O.)

14650 MONITORING DECONTAMINATION AND BIO-ASSAY OF A PLUTONIUM-CONTAMINATED INJURY. Vernon, P. B.; Hall, R. M.; Poda, G. A. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Health Phys., 12: 1539-43(Nov. 1966).

A plutonium-contaminated puncture wound sustained in a processing facility necessitated extensive monitoring and bio-assay surveillance to determine the extent of plutonium deposition and the effectiveness of decontamination measures. A general description of the wound incident, the monitoring techniques used, a tabulation of decontamination and bio-assay data, and suggestions for future consideration are presented in this paper. (auth)

14651 COMPARISON OF URANIUM CASES SHOWING LONG CHEST BURDEN RETENTIONS. West, C. M.; Scott, L. M. (Union Carbide Corp., Oak Ridge, Tenn.). Health Phys., 12: 1545-55(Nov. 1966).

Routine in vivo gamma spectrum measurements have been made to estimate internal exposure to uranium for approximately 2500 persons at the United States Atomic Energy Commission's Y-12 Plant. With only five exceptions, all cases exhibited normal elimination patterns. The five exceptions showed extended biological half-lives of from 380 to 1470 days. The detection of these cases was possible because of the use of the direct-measuring technique of in vivo spectrometry. In vivo, urine and fecal data on these persons have been obtained and evaluated. The uranium urine excretion rate was found to decrease more rapidly than the chest burden. The urine and fecal elimination rate on these employees after their removal from uranium exposure was determined to be about equal. (auth)

14652 HEALTH PHYSICS PROBLEMS DURING THE DEMOLITION OF HIGHLY RADIOACTIVE CHEMICAL PROCESSING PLANTS. Clayton, R. F. (Atomic Energy Research Establishment, Harwell, Eng.). Health Phys., 12: 1571-80(Nov. 1966).

The problems are presented of the radiological protection of personnel engaged in the demolition of radioactive processing

plant and the subsequent decontamination of the laboratory, and the methods used to overcome them are described. The operation was carried out in high level fields of ionizing radiations and in the presence of large amounts of surface contamination. The radiation doses received by the operators are reported (maximum whole body dose 3.15 rem) and the significance of doses to the lens of the eye (maximum dose received 5.33 rem) as a limiting factor is indicated. The difficulty experienced in gaining access to the plants demonstrated the advisability of considering decontamination, demolition and disposal problems during the design and construction phases of radioactive plant. (auth)

14653 ^{90}Sr IN HUMAN BONE (DENMARK 1962–1964). Levi, H.; Lindemann, J.; Nielsen, A. (Univ. of Copenhagen). Health Phys., 12: 1635-7(Nov. 1966).

Data on strontium-90 content in bones of fetuses and children up to 10 yr of age in Denmark are given in tabular form. A steady increase during the period June, 1962–June, 1964 is shown. (C.O.)

14654 SOLID-STATE ALPHA COUNTERS: A REPLACEMENT FOR NUCLEAR TRACK COUNTING IN BIOASSAY PROCEDURES. Butler, H. L.; Splichal, W. F. Jr. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Health Phys., 12: 1627-30(Nov. 1966). (DPSPU-65-30-6).

The advantages of using solid-state alpha detectors over nuclear track counting for monitoring bioassay samples are considered. The results of monitoring uranium and plutonium-239 in urine by each method are statistically analyzed. (C.O.)

14655 ABSORPTION OF TRITIATED WATER VAPOR BY PEOPLE. Osborne, R. V. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Health Phys., 12: 1527-37(Nov. 1966).

People working near heavy water reactors may be internally contaminated by tritium absorbed through the lungs and skin following accidental release of tritiated water. To establish the possible extent of this contamination volunteers have been exposed to tritium in air concentrations 0.5–50 μc/l. for 1.5–60 min. Tritium uptakes were determined by measuring the concentration of tritium in urine and estimating the volume of body water. Tritium was also measured in exhaled water vapor. The intake rates for three unprotected subjects were 14.8, 14.8 and 17.9 μC/min per μC/l. The average skin intake rate for seventeen subjects was 9.6 (in the same units), individual rates being within the range 6.6–13.4. In exposures when clothing and oronasal masks were worn the intakes were as follows: cotton overalls—5.4–13.0; 4-mil polyvinyl chloride (PVC) suits—0.6, 1.0; 4-mil PVC suit over cotton overalls—0.09–0.19; 6-mil, two-piece PVC suit over cotton overalls—0.2, 0.5; overalls between two 4-mil PVC suits—0.01–0.04. Tritium dispersed in the body fluids with half-periods between 19 and 55 min and was eliminated from the body with half-lives between 6.4 and 14.4 days. (auth)

14656 A SPECIFIC ACTIVITY METHOD FOR DERIVED WORKING LIMITS OF ^{32}P. Dyson, E. D. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Health Phys., 12: 1521-6(Nov. 1966). (AHSB(RP)R-55).

Bone growth in children is described, and the specific activity of ^{32}P in their metaphyses is estimated. The carcinogenic effect of ^{32}P in bone and its effect on bone cell kinetics, in experimental animals, is compared with that of external X- and gamma-irradiation. Since the reported effects, per rad, are similar, the same maximum permissible dose rate in growing metaphyses is used for each radiation. The ratio between ^{32}P specific activity in growing bone and in diet is calculated, and the maximum permissible specific activity in diet is found to be 6×10^{-3} μC/g phosphorus. This leads to a derived working limit of ^{32}P in milk for young children of 6×10^{-6} μC/cm^3. More biological data could lead to a further relaxation of this limit. (auth)

14657 RADIATION DOSE FRACTIONATION AND TUMOR CONTROL PROBABILITY. Suit, Herman; Wette, Reimut (Univ. of Texas, Houston). Radiat. Res., 29: 267-81(Oct. 1966).

The effect of x radiation dose fractionation on probability of tumor cure has been studied by using 4-mm^3 isotransplants of the C_3H mouse mammary carcinoma growing in the mouse ear. Irradiation was given in one, two, or ten dose fractions, each irradiation administered under conditions of local tissue hypoxia. The TCD_{50} (tumor control dose) at 120 days after treatment was 4575, 5190, and 8400 rads. These results were interpreted as showing that the sublethal radiation energy could be rapidly and extensively repaired in the hypoxic mammary carcinomal cell of the C_3H mouse. Finally, responses of model tumors were discussed which demonstrated the near impossibility of discriminating between the multitarget and the multihit response law by analysis of radiation-dose tumor-control response curves. (auth)

14658 INJURY ACCUMULATION AND RECOVERY IN SHEEP EXPOSED TO PROTRACTED ^{60}Co GAMMA RADIATION. Hanks, G. E.; Ainsworth, E. J.; Leong, G. F.; Nachtwey, D. A.; Page, N. P. (Naval Radiological Defense Lab., San Francisco). Radiat. Res., 29: 211-21(Oct. 1966).

A modified split-dose technique was used to measure residual injury present after protracted exposures of the domestic sheep to ^{60}Co γ-radiation. A protracted exposure of 165 R was given at 0.5, 0.95, 1.85, or 3.94 R/hour, and the acute $LD_{50/60}$ was determined immediately thereafter by exposing animals at approximately 10 R/min. After exposures at 0.5 or 0.95 R/hour, the single-exposure high-dose-rate $LD_{50/60}$'s were essentially the same as that for previously unirradiated animals. However, after exposures at 1.85 or 3.94 R/hour, the $LD_{50/60}$'s were lower than that for previously unirradiated animals. These studies indicated that the dose-rate threshold for injury accumulation during protracted irradiation lies between 1.0 and 1.5 R/hour. Recovery from injury accumulated during protracted exposures has been studied by determining the $LD_{50/60}$ at various times after protracted exposures. These studies indicated a rapid recovery without a lag period that proceeded to transient acquired radioresistance at 15 days after the conclusion of protracted irradiation. (auth)

14659 CURRENT STATUS OF RADIATION PROTECTION IN DENTAL PRACTICE. Reckow, J. F. (Zahnaerztliche Univ., Frankfurt am Main). Radiologe, 4: 293-304(Sept. 1964). (In German).

Dental radiation protection is discussed in terms of the position that the x-ray equipment is used, the methods used in handling the shielding of the radiation beam, and the methods used for placement and use of dental films. Most defects in radiation protection result from the improper location of areas from which the x-ray equipment is operated. This is particularly true, because in many cases the x-ray equipment is installed centrally in the treatment room. For this reason the dental profession cannot be indifferent to x-ray protection measures. Positions of the dentist relative to the patient during x-ray use are illustrated and compared, the path of the x-ray beam is compared under various conditions, and the advantages and disadvantages of several methods of film handling, shielding location, etc are discussed. The application and importance of conforming as closely as possible with pertinent radiation safety regulations are emphasized. (BBB)

14660 A SIMPLE GRAPHIC METHOD FOR DOSE DISTRIBUTION DETERMINATION IN ^{192}Ir WIRE IMPLANTS. Erjavec, M.; Cevc, P. (Inst. of Oncology, Ljubljana, Yugoslavia). Radiobiol. Radiotherap., 7: 467-72(1966).

The dosimetry of parallel ^{192}Ir wire implants by a graphic method is described. The procedure enables the determination of a complete dose distribution in one main plane of the implant. A standard set of isodose charts has been prepared for single and twin wires of different lengths which can also be used in dosimetry of ^{60}Co, ^{182}Ta, and other γ-emitting isotopes. The procedure is quick and is suitable for individual dosimetry. Its accuracy remains within the limits of clinical needs. (auth)

14661 UNIFORM DOSE CALCULATION IN HARD AND ULTRAHARD RADIATION. Hegewald, H. (Univ., Berlin). Radiobiol. Radiotherap., 7: 457-65(1966). (In German).

Dose determination in moving-beam therapy is already improved and simplified by the use of tissue-air dose ratios. The dose values for reference in air depend on electron contamination and the portion of scattered radiation in the primary radiation beam. They are limited to the depth of the maximum dose by the build-up effect, an exact measurement under electronic equilibrium conditions no longer being possible with ultrahard radiation. For the uniform consideration the suggestion will be used to choose the dose at a defined depth of the phantom as a desired value which simultaneously represents the dose at the rotation axis. The results of measurements of tissue–phantom dose ratios for ^{60}Co γ radiation and 17-MeV betatron x radiation are represented. (auth)

14662 THERMOLUMINESCENCE DOSIMETRY OF GYNAECOLOGICAL RADIUM APPLICATIONS. Reichel, G.; Morczek, A.; Weise, W. (Medizinische Akademie, Magdeburg, Ger.). Radiobiol. Radiotherap., 7: 427-35(1966). (In German).

The use of LiF thermoluminescence dosimeters for measuring the γ radiation dose in rectum and bladder in the radium therapy of the female genital carcinoma is reported. Experimental results about the radiation distribution in bladder, rectum, and the adjacent portion of intestine and in the ureters are described in this work. The examinations were performed on 53 gynaecological patients treated with radium. These in vivo results could be confirmed by phantom measurements. (auth)

14663 TRENDS WITH TIME OF FALLOUT ^{90}Sr, ^{137}Cs, AND ^{95}Zr-^{95}Nb IN TOTAL DIET AND THE CONCENTRATION IN THE AIR. Akaishi, Jun; Kasai, Atsushi; Fujita, Minoru (Japan

Atomic Energy Research Inst., Tokyo). J. Radiat. Res., 7: 8-17 (Mar. 1966).

The changes with time of the dietary levels of fallout ^{90}Sr, ^{137}Cs, and $^{95}Zr-^{95}Nb$ at Tokai-mura, Ibaraki Pref., Japan (36°36′ N, 140°27′ E) were determined during the time from 1962 to 1965. During these four years total diets were collected for thirteen periods, each period of time consisting of 5 consecutive days. The mean daily intakes for 5 days were determined. On the other hand, surface air dust was continuously collected and mean monthly concentration was measured. The levels of these nuclides in the diets and the air were minimum in the summer of 1962. The air concentration of $^{95}Zr-^{95}Nb$ reached the maximum in the spring of 1963. However, it decayed thereafter rapidly. This variation of $^{95}Zr-^{95}Nb$ with time was similar to that of the dietary level. The level of ^{137}Cs in the diet increased since the summer of 1962, reaching about 10 times higher level in 1964. The dietary level of ^{90}Sr also increased but it was not so conspicuous as ^{137}Cs. The dietary level of ^{90}Sr and ^{137}Cs changed in parallel to concentrations in the air, although the latter fluctuated more intensely than the former. (auth)

14664 MEAN LEVEL OF NATURAL RADIOACTIVITY IN THE SURFACE AIR IN JAPAN. Murayama, Nobuhiko (Meteorological Agency, Tokyo). J. Radiat. Res., 7: 1-7(Mar. 1966).

Monthly mean concentration of radon daughters in surface air resulting from natural radioactivity was estimated by use of the survey data of radioactivity obtained at five stations in Japan for the past ten years and assuming the radioactive equilibrium. An overall mean was 90×10^{-18} Ci per cm^3 of the air. Data on ^{214}Pb in surface air are tabulated. Causes of errors accompanying the measurement and estimation are discussed. (C.H.)

14665 INVESTIGATIONS OF THE ACCURACY ATTAINED IN ROUTINE FILM BADGE DOSIMETRY. Langmead, W. A.; Adams, N. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Health Phys., 13: 167-80(Feb. 1967). (AHSB(RP)R-62).

Two experiments were performed to provide data on the accuracy attained in the routine assessment of radiation doses to personnel by means of film badges. In the first experiment, performed at the end of 1961, measurements were made by means of a pressed tin-plate badge of relatively simple design, which was in general use at that time for radiation monitoring the staff of the U.K. Atomic Energy Authority. In the second experiment, the more recently introduced AERE/RPS multifilter plastics film holder was used in the measurements. In both experiments each participating establishment supplied a number of film dosemeters for irradiation with doses of x-, γ- and β-radiation, known only to the investigators. The dosemeters were then returned to the establishments for dose assessment. The results of the dose assessments obtained in the two experiments were compared. It is shown that the AERE/RPS multifilter film holder enables improved accuracy to be attained; the most significant improvements arise from the elimination of the over-estimates of dose obtained for some x- and γ-ray mixtures with the earlier dosemeter as a consequence of its inability to identify a soft-radiation component as x-rays or β-rays. (auth)

14666 COST AND MAN YEAR EFFORT ASSOCIATED WITH THE HEALTH PROTECTION PROGRAMS OF FOURTEEN VARIED AEC CONTRACTORS. Lenhard, J. A.; Heacker, H. V.; Hervin, R. L.; Thornton, W. T. (Oak Ridge Operations, Tenn.). Health Phys., 13: 181-8(Feb. 1967).

The contractors included in the study varied markedly in size and function, ranging from small single purpose production operations to the operation of large and diversified nuclear research institutions. The cost and effort involved in the industrial medical, industrial hygiene, and health physics programs for each contractor are tabulated, normalized to unit cost and effort per employee, and compared with similar and dissimilar operations. Costs and effort for providing total health protection surveillance within the facilities were found to vary greater than one order of magnitude. This variance, which is due almost entirely to the magnitude of the health physics effort, is discussed and justified. (auth)

14667 RADIATION PROTECTION TRAINING OF INDUSTRIAL EMPLOYEES. Reinig, W. C.; Kauffman, G. E. C. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Health Phys., 13: 223-5(Feb. 1967). (DP-MS-66-53).

Radiation safety training at the Savannah River Plant since the commencement of operations in 1951 is described. The plant consists of fuel preparation facilities, reactors, and radiochemical separation areas. The training programme is presented to illustrate a philosophy and methods that may, at least in part, be useful at other locations. (UK)

14668 ESTIMATION OF THE AIR DOSE FROM THE ATOMIC BOMBS IN HIROSHIMA AND NAGASAKI. Hashizume, T.; Maruyama, T.; Shiragai, A.; Tanaka, E.; Izawa, M.; Kawamura, S.; Nagaoka, S. (National Inst. of Radiological Sciences, Chiba, Japan). Health Phys., 13: 149-61(Feb. 1967).

The air dose outside of buildings due to primary and scattered radiation from atomic bombs in Hiroshima and Nagasaki was estimated as a function of distance from the hypocenter. Neutron dose was estimated from ^{60}Co activity in iron imbedded in concrete and γ dose from thermoluminescence in bricks and tiles. The precision (coefficient of variation) of estimation was less than 0.11 for γ-rays and less than 0.15 for neutrons. The results show only a minor difference from other earlier estimations for γ and agree for neutrons in Nagasaki, but show a large difference of approximately 50 percent for neutrons and 30 to 70 percent for γ rays at distances from 500 to 1500 m from the hypocenter for Hiroshima. (auth)

14669 EFFECTS OF DESFERRIOXAMINE ON THE RETENTION OF ACTINIDE ELEMENTS IN THE RAT. Taylor, D. M. (Inst. of Cancer Research, Sutton, Eng.). Health Phys., 13: 135-40(Feb. 1967).

The effectiveness of desferrioxamine (DFOA) and diethylenetriaminepenta-acetic acid (DTPA) in reducing the retention of ^{239}Pu, ^{241}Am, ^{244}Cm, ^{227}Ac, and ^{228}Th was compared in rats. It was found that DFOA is only slightly less effective than DTPA in reducing the retention of ^{239}Pu provided that treatment is commenced within a few hours of exposure. If the start of the treatment is delayed until 7 days after exposure to ^{239}Pu, DFOA is ineffective. Unlike DTPA, DFOA does not reduce the retention of ^{241}Am, ^{244}Cm, or ^{227}Ac and produces only a slight reduction in the retention of ^{228}Th. (auth)

14670 GENETICALLY SIGNIFICANT DOSE FROM DIAGNOSTIC RADIOLOGY IN CAIRO AND ALEXANDRIA. Mahmoud, K. A.; Mahfouz, M. M.; Atiyah, I. R.; El-Naggar, A. M.; Molokhia, M. M. (Atomic Energy Establishment, Cairo). Health Phys., 13: 163-6 (Feb. 1967).

Techniques from medical diagnosis during 1955 to 1961 used for computation of the genetically significant dose are explained. Data on annual frequency of x-ray examinations, as well as dose rates to the gonads during various types of x-ray exposures, are also provided. It was concluded that the total annual genetically significant dose for Alexandria was about one-quarter of that for Cairo. (TSS)

14671 RADIOACTIVITY IN URANIUM MINES OF EAST BAVARIA. Reiter, R.; Poetzl, K. (Fraunhofer-Gesellschaft, Garmisch, Ger.). Zentralbl. Biol. Aerosol Forsch., 13: 217-62(Dec. 1966). (In German).

The individual components of the radioactivity found in uranium mines were defined and described and the resultant radiation burden to miners was estimated. The following measurements were carried out: radiometric measurements of the radon concentration, equilibrium state of radon decay products, dust measurements for uranium and radium content, particle size distribution, and temperature and dampness measurements, uranium, radium, and radon concentration in mine waters, and β and γ activity of environmental air samples. The measurement methods are described and the results are tabulated, discussed, and compared with results obtained in other countries. If the maximum permissible radiation dose is set at 0.1 rem/work week, then a concentration of 5×10^{-8} μCi/cm^3 radon in the mine water is permitted when all components of the radioactivity climate underground are considered. The radon measurement values in the mines investigated varied from slightly under to significantly over this value. (82 references.) (tr-auth)

14672 RADIATION ENERGY SHIELD PROTECTING A BODY AREA OF A PATIENT FROM X-RAYS AND THE LIKE. Pretto, John I. U. S. Patent 3,286,094. Nov. 15, 1966. Filed Mar. 24, 1964.

A radiation shield is described which is designed for use in protecting body areas of a patient during exposure to ionizing radiation as from x-ray examination or treatment. The shield is in the form of a folding fan-like device which may be expanded or contracted for varying the area of the body portion to be shielded. (S.F.L.)

Medicine

Refer also to abstracts 14638, 14639, 14642, 14659–14662, 14722, 14724, 14731, 14732, 14747, 14750, and 14757.

14673 (BNWL-280, pp 12) ALIMENTARY PASSAGE OF ALLYL INULIN. McKenney, J. R.; Keough, R. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Iodine-131-labeled allyl inulin was tested in rats as a possible inert, soluble food label for use in studies of gastrointestinal function and was found to be unstable in inorganic phosphate-buf-

fered saline at pH values in the biological range. Qualitative differences in the passage rates of ^{131}I- and ^{144}Ce-allyl inulin may be explained by differences in their physical and biological behavior. (auth)

14674 (COO-78-150) AN EVALUATION OF THE COMBINED RESPONSE TO X-RAYS AND CHEMICAL AGENTS. Marsh, Howard John (Western Reserve Univ., Cleveland, Ohio. Div. of Biometry). Sept. 1966. Contract AT(11-1)-78. 225p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

The combination of chemotherapy and radiotherapy in the treatment of malignant diseases has been advocated in the hope that a response could be achieved with the combination that was unobtainable with either therapy alone. The experimental evidence for this possibility is both abundant and contradictory. An attempt was made to employ the statistical techniques of experimental design, mathematical model building, parametric estimation, and statistical testing of hypotheses in order to clarify the problem of evaluating the combined effects of chemotherapeutic agents and x radiation. Murine leukemic lymphoblasts growing in tissue culture were chosen for the biological system in which the combined effect was evaluated. X radiation and the chemotherapeutic agent 5-iododeoxyuridine (IUDR) were administered to the tissue culture system as defined by a 4×4 factorial design. By including the zero dose level for each agent in the factorial design, it was possible to include untreated cells, singly treated cells, and cells treated with combinations of both agents in each experiment. Growth characteristics of the treated cells were observed directly and they provided the basis for the mathematical estimation of the proportional mortality response. It was concluded that, under the experimental conditions used, x radiation and IUDR acted as dissimilar agents, whose effects were simply additive. (73 references.) (C.H.)

14675 (NP-tr-1495) STUDIES IN SCINTIGRAPHY OF THE PANCREAS. Laconi, A.; Melfi, F.; (and others). Translated by O. S. Whitston (Atomic Energy Research Establishment, Harwell, Eng.), from Minerva Med., 56: 3645-52(1965). 20p. Dep. mn. JCL $1.60 fs, $0.80 mf.

The importance of studying labeled substances for possible selectivity towards pancreatic tissue is pointed out. The results of studies using selenomethionine-^{75}Se in radiodiagnosis obtained by other workers discussed. Distribution and concentration of selenomethionine-^{75}Se in the dog were studied. The concentration in the pancreas was found to be about 5 times higher than that in the liver. Scintigrams were obtained after 24 hours exposure of the organs of a dog sacrificed 2 hours after introduction of selenomethionine-^{75}Se. The relative concentrations in various organs as compared with the pancreas were as follows: liver, 20%; kidney cortex, 23%; kidney medulla, 16%; lungs, 13%; spleen, 12.5%; heart, 10%; and prostate, 9%. Clearance and regional distribution values of selenomethionine-^{75}Se after intravenous injection in 2 human subjects 2 hours after food intake were determined. Blood samples were taken at intervals beginning 2 min after injections. A fall in the blood level occurred after 30 to 40 min and this was followed by a rise to a constant level. Regional distribution values were determined in the same subjects. Activity in the liver increased gradually for 20 min, while the pancreas was instantaneous, remained constant for $1\frac{1}{2}$ hours, and then decreased gradually. Advantages and limits of scintigraphy were studied by experiments on 5 dogs. Results were inconclusive because of the insufficient concentration of the tracer in the pancreas and because of the short-lived activity in the gland. It is concluded that pancreas scintigraphy with selenomethionine-^{75}Se can be considered a first step in radiodiagnosis. (H.L.W.)

14676 COLONIC IRRADIATION IN HYPERCHLORAEMIC ACIDOSIS FOLLOWING URINARY DIVERSION IN DOGS. Luck, R. J.; Irvine, W. T. (St. Mary's Hospital, London). Brit. J. Urol., 38: 283-7(June 1966).

Irradiation of the colon was explored as a possible means of preventing hyperchloremic acidosis, which occurs in ~80% of patients after ureterosigmoidostomy and may lead to severe symptoms and even coma and death. Since colonic absorption (or exchange) of ions is of primary importance in this condition, any method of diminishing ionic movement across the mucous membrane should benefit the patient. It was shown that colonic absorption of Na and Cl can be reduced by local irradiation of the colonic mucosa. It was therefore tested whether such irradiation could protect dogs from the effects of urinary diversion. Irradiation was performed by introducing a balloon filled with $^{90}YCl_2$ solution into the colon. A dose of between 2000 and 3000 RAD produced both ulceration of the colon and depression of adsorption but 500 RAD depressed absorption without histological damage. Doses of 800 and 1000 rad were therefore used to treat the mucosa. The values obtained for plasma CO_2, plasma Cl, and blood pH in the animals before and after urinary diversion (all animals having had colonic irradiation 3 weeks previously) showed that irradiation failed to prevent the development of a severe acidosis. The amount of colonic mucosa irradiated was estimated at 70 and 85% of the total. The absence of histological damage to the kidneys and evidence of renal hypertrophy in the presence of a severe acidosis confirmed that the development of hyperchloremic acidosis depends primarily on excessive absorption from the colon which provides the kidney with a large acid and osmotic load rather than on renal damage. It is possible that colonic irradiation may reduce acidosis, but since in man probably 1 Ci of ^{90}Y would be required in each patient to deliver adequate irradiation, the difficulties and dangers would outweigh the advantages, if any, of the method. Therefore, it is concluded that colonic irradiation has no clinical application in hyperchloremic acidosis. (BBB)

14677 STATISTICAL STUDY ON THOROTRAST-INDUCED CANCER OF THE LIVER. Takahashi, Shinji; Kitabatake, Takashi; Yamagata, Shoichi; (and others) (Nagaya Univ., Japan). Tohoku J. Exp. Med., 87: 144-54(Nov. 25, 1965).

Three studies were made in an epidemiological survey of Thorotrast-induced cancer; these included prospective, retrospective, and autopsy report studies. In the prospective study, of 147 Thorotrast-injected patients surveyed, 3 cases of liver cancer (cholangiocarcinoma), 2 cases of liver cirrhosis, and 1 case of leukemia were found, while in 1678 of noninjected control subjects there were 1 case of leukemia, 5 cases of liver cirrhosis, and no liver cancer. In retrospective study, of 466 liver cancer patients surveyed, 4 or 0.85% had a Thorotrast shadow in the roentgenogram of the upper abdomen, while in 1938 controls only 1 or 0.07% showed the Thorotrast shadow. Statistically the Thorotrast-retention rate was higher in liver cancer patients than in controls. In the autopsy case study, of 38 autopsied cases of Thorotrast deposition, 21 were primary liver malignancy, which consisted of 4 hepatomas (19%), 14 cholangiocarcinomas (65%), and 3 endotheliomas (14%). As compared with the autopsy cases of control Japanese subjects, cholangiocarcinoma and endothelioma were extremely frequent in the Thorotrast cases, a statistically significant difference being noted. (BBB)

14678 X-RAY INTENSIFYING SCREENS: QUALITY OF ROENTGENOGRAMS AND DOSAGE REQUIREMENTS AS RELATED TO THE SIZE OF LUMINOUS CRYSTALS. Angerstein, W.; Plapperer, H. (Forschungsinstitut fuer Tuberkulose and Lungenkrankenheiten, Berlin). Roentgenpraxis, 18: 16-21 (Jan. 1965). (In German).

Studies were carried out to determine the effect of screen crystal size on the quality of x-ray photographs. Screens were prepared from 5 fractions of Ca tungstate crystals having diameters between 2 and 8 μ. The maximum frequency of the diameter of the Ca tungstate used was from 3 to 3.5 μ. The screens contained 6, 11, 25, 50, 75, and 100 mg/cm^2 with gelatin as a binder. The relative screen brightness was measured with a photomultiplier after excitation with a ^{85}Kr source with a maximum at 70 keV. Quality tests were made of the visual resolution characteristics measured by a Pb-graticle rastar and photometric measurements of differences in blackening on films produced by a Pb graticle. The resulting curves were proportional to, but not identical with, the contrast transmission curves. For layer densities greater than 50 mg/cm^2, the light output of the screens used as forescreens decreased. Generally, the light output increased in proportion to the crystal diameter. With layer densities greater than 30 mg/cm^2 differences in crystal sizes from 2 to 8 μ had no effect on the contrast transmission. The quality of the films was not improved by the use of crystal <5 μ in diameter, was constant for crystals from 5 to 10 μ in diameter, and was effected more by layer density than by crystal size as long as the diameter was <10 μ. (TSS)

14679 ALTERATIONS IN ^{203}Hg ISOTOPIC KINETICS IN EXPERIMENTAL RENAL ISCHEMIA: CORRELATION WITH RENAL HEMODYNAMICS AND METABOLISM. Johnston, Gerald S.; Murphy, Gerald P.; Schirmer, Horst K. A. (Walter Reed General Hospital, Washington, D. C.). J. Urol., 96: 606-13(Nov. 1966).

The possibility of demonstrating significant changes in renal radiomercury-chlormerodrin kinetics as a diagnostic aid in hypertensive renal ischemic states was explored. Urinary concentration, excretion rate, and intrarenal distribution of ^{203}Hg-chlormerodrin were experimentally determined in 25 dogs with stenosis of the left renal artery (50 to 80%), with and without a contralateral intact kidney, and with and without treatment using the ganglionic blocking agents. These studies demonstrated that decreases in urinary and renal concentration of this isotope reflect renal ischemia and tubular damage and are not diagnostic of renal hypertension, solely. Secondary alterations in the urinary and cortical concentration of ^{203}Hg-chlormerodrin reflect hexa-

methonium-induced improvements in renal hemodynamics and metabolism and offer possible clinical therapeutic aid in renal ischemic states. Changes in ^{203}Hg urinary concentration with and without hexamethonium are diagnostic of renal ischemia, and not necessarily of renal hypertension. Such urinary isotope measurements can be simply and rapidly completed during the performance of clinical split function tests, and will assist in the evaluation of the level of renal functional impairment. (BBB)

14680 ELECTRON THERAPY FOR TUMORS OF THE HEAD AND NECK. Schoen, D. (Univ., Tuebingen, Ger.). Deut. Med. Wochenschr., 91: 1692-7(Sept. 23, 1966). (In German).

Necrosis of the mandibulum is less frequent after treatment of lip carcinomas with high-energy electrons than after γ irradiation. Using 6 to 12 MeV electrons a total dose of ~6000 R given in 6 weeks is required. Destruction of the hypophysis cannot be attained with electrons without injury to parasellar structures. When percutaneous irradiation with heavy particles from a cyclotron is not available, surgery or implantation of radioisotopes is preferred for adenomas, metastatic mammary carcinomas, diabetic retinopathy, and malignant exophthalmus. In cases of thyroid carcinoma after subtotal resection, pendulum irradiation with electrons is important to provide for optimal protection of the bone marrow and avoid radiogenic myelopathy. A total dose of 11,000 R of 25-MeV electrons is required for preoperative irradiation of oral cavity tumors, but ^{60}Co therapy is preferable because of the more homogeneous dose distribution and better protection afforded to the eyes. However, electrons appear to give better early results. The 3-yr results of electron treatment of epipharyngeal tumors are not as good as after ultrahard photon irradiation, but they are better than after irradiation with conventional x ray. Electron therapy appears to be less effective than ultrahard protons for oropharyngeal tumors, but limited data are available. Electron irradiation of the jaw may permit higher doses to be administered for tumors of the oral cavity since the metabolism of the mandibular bone remains relatively intact, which is important for the final result. Electrons are relatively effective for lymph node irradiation. (TSS)

14681 RECENT ADVANCES IN THE FIELD OF CHEMICAL AND BIOLOGICAL PROTECTION FROM DAMAGE DUE TO IONIZING RADIATIONS. Solarino, Giuseppe (Univ., Bari, Italy). Rass. Clin.-Sci., 41: 104-10(Apr. 1965). (In Italian).

Chemical and biological radioprotection agents are reviewed, including a discussion of the effects of anoxia, thiol compounds such as mercaptoethylamine, hormones, vitamins, antibiotics, serum antibacterial factors, reticuloendothelial system stimulants, and tissue homogenates. Studies on the use of endogenous antibiotics in particular are reviewed. Thus thymus peptides were shown to ameliorate the acute and chronic effects of x-irradiation in rabbits. Such animals survived 27 hr after a 2000-R dose when pretreated with 5 mg/kg body weight of the peptides compared to only 4 hr in untreated rabbits. Favorable effects were also seen in rabbits exposed to 100 R/day. The same dose of tissue peptides prolonged life for 32 days compared to only 20 days in control rabbits. It was shown that properdin (25 units/kg) prolonged the life of acutely irradiated (2000 R) rabbits from $2\frac{1}{2}$ hr in controls to 32 hr, and of chronically irradiated (100 R/day) animals from 19 days to 37 days. Lysozyme was shown to have a similar radioprotective effect in both short- and long-term experiments. (BBB)

14682 PRACTICING PHYSICIAN AND THE NUCLEAR REACTOR. Klutz, William S. (Roger Williams General Hospital, Providence); Quirk, Arthur I. Rhode Island Med. J., 49: 176-8 (Mar. 1966).

The reactor at the Rhode Island Nuclear Science Center and its associated facilities for research are described and its possible medical applications are discussed. The reactor, presently operating at a power level of 1 MW but having a built-in capability of 5 MW, was constructed by the General Electric Co. and is operated by the State, acting through the Rhode Island Atomic Energy Commission. The core of the reactor, consisting of 3 kg of ^{235}U, is located at the bottom of highly purified light-water tank 32 ft deep. A special facility is available for the irradiation of materials and small animals whereby a system of pneumatic tubes moves small carriers (called rabbits) quickly into proximity to the core, where they are irradiated for the desired time and then returned to the station on the main reactor floor. A well-equipped radiochemistry laboratory is part of the reactor complex and is equipped with a 512-channel analyzer, providing for the rapid and precise identification of various elements through activation analysis. Use of the reactor for production of short-lived isotopes and for studying neutron capture theory is also described. (BBB)

14683 SEALING PROPERTIES OF ENDODONTIC FILLING MATERIALS USING RADIOACTIVE POLAR AND NONPOLAR ISOTOPES. Kapsimalis, Peter; Evans, Richard (Temple Univ., Philadelphia). Oral Surg., Oral Med., Oral Pathol., 22: 386-93 (Sept. 1966).

A modified autoradiographic technique was developed that resulted in an improvement in the quality of autoradiographs for interpretation of results in marginal penetration studies. It was applied to the study of the comparative sealing properties of commonly used and recently advocated endodontic filling materials, using polar and nonpolar radioisotope-labeled substances. These radioisotopes were used to determine the effectiveness of the cementing media and to measure leakage through the apex of the tooth and into the filled root canal. Radiosulfur, as $^{35}SO_4$, an inorganic anion was used because of its ionic particle size, polarity, and ability to produce a sharp image; tritiated glucose was used because of its molecular size and nonpolarity; and tritiated proline was selected because of its molecular size and polarity. Recently extracted noncarious upper anterior teeth were used as test specimens. According to the modified autoradiographic technique described after exposure to the isotopes, each root canal specimen was cut serially into 300-μ sections across the long axis of the root. Photographic emulsions were used to sandwich the tooth specimens and were held in tight contact by clamps. The clear glass plates allowed a combination of reflected and transmitted light to pass through for photographing a composite autoradiograph of the positional relation of tooth specimen to isotope penetration pattern. Gross leakage patterns resulted when tooth specimens were filled only with central cores of either gutta-percha or silver cones without cement. A gradient of leakage patterns was observed when eight root canal cements were tested in conjunction with central cores of silver or gutta-percha. Of the eight root canal cements tested with ^{35}S and tritiated glucose, only Proco-Sol and AH-26 showed no leakage. Variable results were obtained when the root canal cements were tested with tritiated proline at pH 4.8 and pH 8.2; Kloroperka N-O, Diaket, Pulpdent's PCA, and Kerr sealer exhibited leakage. (BBB)

14684 RADIATION THERAPY OF MALIGNANT LARYNGEAL NEOPLASMS. Wang, C. C.; Schultz, M. D. (Massachusetts General Hospital, Boston). Eye, Ear, Nose, Throat Mon., 45: 33-8(Aug. 1966).

Dose considerations and complications of radiotherapy are reported. In radiation therapy for carcinoma of the larynx, the margin between success and failure is limited. Radiotherapeutically, it requires a high dose of radiation to a limited volume of tissue. To accomplish this, supervoltage radiation with energy at or above 1 MeV has definite advantages, including skin- and bone-sparing effects, better depth dose, and sharper radiation beam. A full course of radiation therapy can be given through a single portal of entry without significant skin reaction. The optimal dose of radiation is ca 6000 to 7000 rad of supervoltage radiation, in 6 to 7 weeks, or its time–dose equivalent. This dose is largely influenced by the tumor type, irradiated volume, frequency of fractionation, total course of treatment, and response of the tumor and adjacent normal tissues to irradiation. In general, the smaller the volume, the longer the protraction, the higher the dose that can be delivered. A carefully controlled irradiation technique should not produce edema of the irradiated larynx with complications of laryngeal obstruction during irradiation. The necessity for tracheotomy after irradiation generally indicates recurrent disease. Hyperkeratosis of the larynx was observed as a complication in the long-term survivors treated by radiation therapy. It offers a problem of differential diagnosis between a benign condition and recurrent cancer. Usually, conservative therapy is adequate, and unless histologic evidence of recurrent cancer is detected, radical surgery, like total laryngectomy, is ill-advised. Problems of recurrent carcinoma and retreatment by radiotherapy are also discussed. (BBB)

14685 A MODIFIED TECHNIQUE FOR INTRA-ANTRAL RADIUM APPLICATION. Henderson, D. (Queen Mary's Hospital, London); King, Hilary. Brit. Dent. J., 119: 28-32(July 6, 1965).

A description is given of the fabrication of a Ra applicator to treat maxillary cancer, in which a new technique was used to shield normal tissues. Gold was employed instead of the usual lead shielding. A typical case is described for which such an applicator was made. Various aspects of oral radioprotection are considered. (TSS)

14686 POLYMORPHOUS LIGHT ERUPTIONS: PHOTOTEST TECHNIQUE STUDIES. Epstein, John H. (Univ. of California, San Francisco). Arch. Dermatol., 85: 502-4(Apr. 1962).

A method was developed for detecting uv photosensitivity and was applied to 37 patients. Two light sources were used: a hot quartz air-cooled contact lamp that produced an irregular line spectrum extending from the short uv into the infrared range with high energy output in the erythrogenic sunburn range (2900

to 3200 Å); and a carbon arc lamp giving a continuous spectrum with irregular peaks extending from the short uv into the infrared (2200 to 40,000 Å), and with a relatively high-energy output throughout the uv range. A window-glass filter was used to eliminate the sunburn spectrum at control sites. The method produced positive phototests in 32 of 37 patients with polymorphous light eruptions. Positive reactions occurred only to the unfiltered hot quartz spectrum. No abnormal reactions occurred from the carbon arc or hot quartz spectrum passing through the window-glass filter which eliminates wavelengths shorter than 3200 Å. This finding indicates that the clinical action spectrum of these patients lies in the sunburn range (2900 to 3200 Å). No rays shorter than 2900 Å reach the earth's surface from the sun. In general, the small papular and eczematous varieties had lower minimal erythema thresholds and required less energy to produce positive tests than the erythema multiforme and prurigo forms. (BBB)

14687 STUDIES ON THE MOLECULAR MECHANISM OF THE RADIOPROTECTIVE EFFECT OF SEROTONIN. Lohmann, W. (Univ. of Iowa, Iowa City); Moss, A. J. Jr.; Sanders, J. L.; Porter, B. J.; Woodall, D. M. Radiat. Res., 29: 155-65(Oct. 1966).

The radioprotective effect of serotonin creatinine sulfate (5HT) on catalase was investigated. The enzyme–5HT solutions were irradiated with different exposure doses of X-rays (0 to 1.35×10^6 R). The ED_{37} for the highest 5HT concentration used (31 μM) was about nine times as large as that of the control. This protective effect might be explained by a complex formation between Fe^{3+} in the active site of catalase and the protective substance. The existence of such a complex was shown by optical absorption and electron spin resonance studies. A new absorption peak at 315 mμ was observed when 5HT was added to an aqueous iron solution. The change in height of this peak with 5HT concentrations revealed an optimum in height at about a 1:10 ratio of iron chloride to 5HT. Since no changes in the ESR spectra of aqueous metal ion solutions (Fe^{3+}, Cu^{2+}, Mn^{2+}) could be observed, dimethylsulfoxide was used as a solvent. In every case, the addition of 5HT to the solutions resulted in a metal–water-like spectrum. The peak heights of the Cu^{2+} and Fe^{3+} signals decreased, but for Mn^{2+} the peak height was unchanged. Furthermore, in the case of Cu^{2+}, the signal was shifted to a lower g value and the change in peak height was time-dependent. At about equimolar copper chloride and 5HT the rate of the time-dependent decrease in peak height changed from a minimum to a maximum value. At lower and higher 5HT concentrations this rate became concentration-independent. From the ESR results obtained it might be concluded that the 5HT action on Cu^{2+} and Fe^{3+} is very similar, while in the case of Mn^{2+} a different mechanism must be assumed. The differences in results between Fe^{3+} and Cu^{2+} compared to Mn^{2+} might reflect differences in the biological action of these metal ions. (auth)

14688 PERENNIALITY OF RADIODERMATITIS. Afanassieff, A. (Service de Chirurgie, Nanterre, France). J. Chir. (Paris), 90: 187-95(Sept. 1965). (In French).

Ninety five cases of radiodermatitis in professional people following repeated exposure to x radiation are discussed. Often the excessive doses were encountered by surgeons using fluoroscopy to remove foreign bodies and to set bones. Such a practice should be discontinued. The mean latent period for development of radiodermatitis is 3 yr but periods of 30 to 40 yr have been observed. Phases of development of the lesions are described. The only effective treatment of extensive radionecrotic skin consists of surgical removal of the devitalized tissue and replacement with healthy tissue from an unirradiated site. The use of free grafts and pedicle flaps to cover the excised area of skin is discussed, and some details of repairing lesions on the fingers are cited. In some cases it may be necessary to amputate fingers where repair is impossible or cancerous changes widespread. (BBB)

14689 RADIOPROTECTIVE EFFECT OF TOPICALLY APPLIED DIMETHYL SULFOXIDE ON MICE. Moos, W. S.; Kim, S. E. (Univ. of Illinois, Chicago). Experientia, 22: 814-15 (Dec. 15, 1966).

Dimethyl sulfoxide (DMSO) was applied topically to the tails of mice before or after exposure to 700 to 740 R doses of whole-body x radiation. Topical application of DMSO prior to exposure to lethal doses of x radiation afforded considerable protection. Application of the chemical after irradiation did not alter survival significantly from that of control mice. A single treatment with DMSO for 1 to 5 min before irradiation was as effective in providing protection as daily immersions. (C.H.)

14690 RADIATION REPAIR OF CHROMOSOME BREAKS AS EFFECTED BY CONSTITUENTS OF NUCLEIC ACIDS. Beatty, Alvin V.; Beatty, Jeanne W. (Emory Univ., Atlanta). Radiat. Bot., 7: 29-34(Feb. 1967). (ORO-2669-1).

In experiments, with a total dose of 400 R of x rays in a helium atmosphere, Tradescantia inflorescences treated in adenine, guanine, cytosine, uracil, thymidine, adenosine, adenosine 2′-, 3′-, and 5′-monophosphates, adenosine-5′-diphosphate, deoxyadenosine-5′-mono- and 5′-triphosphate did not show an average aberration frequency differing from that of the control in helium. Thymine, guanosine, cytidine, uridine, guanosine triphosphate, thymidine triphosphate and uridine triphosphate treatments reduced the aberration yield by approximately 25 percent. Adenosine triphosphate, cytidine triphosphate, deoxyadenosine, deoxyguanosine, deoxycytidine, deoxyuridine and 3′-5′-diphosphoadenosine effected approximately a 50 percent reduction in aberration yield. It is not thought that the compounds that bring about a reduction in aberration yield do so by reducing the amount of initial radiation damage. Some compounds, as well as the deoxy compounds and 3′-, 5′-diphosphoadenosine, may also be involved directly in the chemical repair of the radiation-induced breaks. (auth)

14691 ENHANCEMENT OF THE POST-IRRADIATION PROTECTIVE ACTION OF TAB BY AN α-ADRENERGIC BLOCKING AGENT. Byron, J. W. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Nature, 213: 635-6(Feb. 11, 1967).

Gram-negative endotoxins or typhoid–paratyphoid A and B vaccine (TAB) can exert a favourable influence on the acute radiation syndrome when administered after whole-body irradiation. By stimulating excessively release of adrenergic neurohormones, or by increasing sensitivity to catecholamines, however, these substances can result in reduced blood flow to the kidneys, liver, and intestines, leading to ischaemia and irreversible tissue damage. Since the full benefits of TAB treatment might not be obtained because of side effects, a study was made to determine whether the radioprotective action of TAB could be enhanced through treatment with an α-adrenergic blocking agent. Mice were used for these studies, and phentolamine methanesulphonate (PMS) was employed as reversible α-adrenergic blocking agent. The use of PMS significantly reduced the mortality below that employing only TAB, this effect being most significant during the third week after irradiation. The results may also suggest a possible mechanism for the radioprotective action of TAB and Gram-negitive endotoxin, including the role of PMS, based on catecholamine release and shock considerations. (UK)

14692 POSSIBILITIES OF THE UTILIZATION OF NEUTRONS IN THE RADIOTHERAPY OF TUMORS. Barendsen, G. W.; van Bekkum, D. W. Atoomenergie Haar Toepass., 8: 252-61(Dec. 1966). (In Dutch).

The possible treatment of tumors with fast neutrons is discussed. One advantage in the utilization of fast neutrons is the significantly large dose reduction factor for the O_2 effect of fast neutrons in comparison with this factor for electromagnetic radiation and fast electrons. (tr-auth)

14693 THE INFLUENCE OF VITAMIN B_{12} AND FOLIC ACID ON RADIATION SYNDROME OF WHOLE-BODY IRRADIATED RATS. Morczek, A.; Schmidt, W. (Medizinische Akademie, Magdeburg, Ger.). Radiobiol. Radiotherap., 7: 487-94(1966). (In German).

The effect of folic acid and vitamin B_{12} upon the course of radiation syndrome was determined on 192 rats x irradiated with 600, 800, 1000, and 1200 R (groups of 24 animals each). After 600 R there was a higher survival rate for both vitamins. Following the administration of vitamin B_{12} the survival rate was significantly increased even after irradiation with 800 R. Examinations of the blood-picture performed in fixed time intervals before and after irradiation showed both vitamins to have a certain stimulating effect upon reticulocytes, erythrocytes, and thrombocytes in the dose ranges of 600 and 800 R. Whereas in reticulocytes and erythrocytes regeneration began immediately, and the initial values were reached again earlier than in animals without an application of vitamins, the radiation-induces decrease after 600 R and 800 R was milder in thrombocytes, the minimum values being higher than in the untreated animals. Following radiation doses of 1000 R and 1200 R no effect favoring regeneration could be demonstrated either for folic acid or vitamin B_{12}. (auth)

14694 INFLUENCING BLOOD AND SERUM CHOLESTERIN LEVEL BY X IRRADIATION. Morczek, A.; Otto, H.-J.; Ebert, G. (Medizinische Akademie, Magdeburg, Ger.). Radiobiol. Radiotherap., 7: 495-501(1966). (In German).

The introduction of the preparation Colsil for prophylaxis and therapy of nervous irritation after x irradiation is based on the assumption that there is a causal connection between a decrease of cholesterin level in the blood following x irradiation

and the development of radiation sickness. It is remarkable how little the base for using the medication is assured. In an examination of patients during irradiations of the abdominal and thoracic area, respectively, we found only changes of blood and serum cholesterin level, respectively, which do not exceed the extent of physiological fluctuation. Colsil proved little suited for the therapy of nervous irritation after x irradiation. Better drugs are available. (auth)

14695 CONTROL OF FIELD ADJUSTMENT BY MEANS OF EXPOSURE WITH THE SOURCE OF COBALT THERAPY UNIT. Schuhknecht, H.-J.; Tietze, D. (Karl-Marx-Univ., Leipzig). Radiobiol. Radiotherap., 7: 415-20(1966). (In German).

Proper films and combinations of foils for field control of the radiation field when using a ^{60}Co therapy unit were determined in a test series. Orwo materials testing films RF 5 and RF 31 in connection with a combination of copper foils 0.5 mm thick seemed to be most suited. Orwo materials testing film RF 63, recently developed, offers a desired shortening of exposure time for certain cases by its higher sensitivity with the same steepness of gradation. (auth)

14696 THE HEPATIC SCAN IN CIRRHOSIS: BIOCHEMICAL AND HISTOLOGIC CORRELATIONS. Rozental, Paul; Miller, Edwin B.; Kaplan, Ervin (Veterans Administration Hospital, Hines, Ill. Univ. of Illinois, Chicago. Loyola Univ., Chicago). J. Nucl. Med., 7: 868-77(Nov. 1966).

The factors influencing the appearance of the ^{131}I-Rose Bengal or colloidal ^{198}Au liver scans in cirrhosis are reduced hepatic blood flow, disturbed parenchymal function, and the presence of areas of parenchymal replacement by necrosis, fatty infiltration, and fibrosis. These contribute to produce the diffuse, focal, or diffuse plus focal appearance of the hepatic scan. A review of 40 cirrhotic patients with stabilized liver function tests showed that half had focal changes in their liver scan. These scans were not diagnostic though they were helpful in indicating a site for biopsy. There was a correlation of diffuse scan appearance with the degree of BSP retention. Also, post-necrotic cirrhosis was more likely to give the diffuse plus focal appearance than was Laennec's cirrhosis. (auth)

14697 BRAIN SCANNING WITH 200 MICROCURIES OF ^{203}Hg CHLORMERODRIN. Buchanan, Donald L. (Veterans Administration Hospital, West Haven, Conn.). J. Nucl. Med., 7: 859-67(Nov. 1966).

Good quality brain scans are obtained after administration of 200 μCi of ^{203}Hg chlormerodrin using a five-inch diameter scintillation crystal and a two-inch thick 91 hole collimator with relatively thin septa. (auth)

14698 STUDIES WITH ^{131}I-LABELED ANTIBODY TO HUMAN FIBRINOGEN FOR DIAGNOSIS AND THERAPY OF TUMORS. McCardle, Robert J. (Argonne Cancer Research Hospital, Chicago. Univ. of Colorado, Denver); Harper, Paul V.; Spar, Irving L.; Bale, William F.; Andros, George; Jiminez, Feliciano. J. Nucl. Med., 7: 837-47(Nov. 1966).

Fifty patients with neoplasms were injected intravenously with purified and ^{131}I-labeled rabbit antibodies to human fibrinogen and were evaluated with scintiscanning for diagnostic reliability. Fifty-six per cent of all tumors showed positive scans and a much higher percentage was obtained in scans of patients with metastases to the brain. Using Beck's formula or head phantoms, in vivo concentration of ^{131}I in the lesions was calculated and from these values estimations were made for 10 patients of the β radiation dose that would be delivered to the tumor if 160 mCi of ^{131}I antifibrinogen were given. These ranged from 123 to 2900 rad. Whole-body radiation (β and γ) was less than 200 rad. Reports are presented for two patients who received therapeutic trials, one of whom showed a regression of the lesion. (auth)

14699 MUSCLE ELECTROLYTE COMPOSITION DETERMINED BY NEUTRON ACTIVATION. A PRELIMINARY STUDY OF DEHYDRATION IN INFANTS. Dubois, J. (Univ. Libre, Brussels); Colard, J.; Vis, H. L. J. Nucl. Med., 7: 827-36(Nov. 1966).

A method is described for the analysis of muscular electrolytes and phosphorus in children by neutron activation of muscle biopsy samples. By comparing our results with those obtained by the chemical technique we came to the conclusion that this method is reliable. An analysis of needle biopsy specimens of muscle from children with different degrees of dehydration suggests that the muscular tissue is rapidly involved in acute hydro-electrolytic disorders. Although the use of such a method is limited, it remains the only one which allows a direct study of tissue in pediatric pathology. (auth)

14700 ELIMINATION OF LIVER INTERFERENCE FROM THE SELENOMETHIONINE PANCREAS SCAN. Kaplan, Ervin; Ben-Porath, Moshe; Fink, Sidney; Clayton, Glenn D.; Jacobson, Burton (Veterans Administration Hospital, Hines, Ill. Univ. of Illinois, Chicago. Loyola Univ., Chicago). J. Nucl. Med., 7: 807-16(Nov. 1966).

A method of scanning the pancreas is described, in which the liver image is eliminated by the subtraction of the ^{198}Au photopeak from that of ^{75}Se. The electronic system is pictured in block and detailed circuit diagram. The system has been useful in consistently producing a pancreatic image. (auth)

14701 ON THE TREATMENT OF HYPERTHYROIDISM, WITH SPECIAL CONSIDERATION OF RADIOIODINE THERAPY AND OF A POSSIBLE RELATED LATER ACUTE RADIATION INJURY OF THE LIVER. Schubert, G. C. (Medizinisch-Biologisches Forschungszentrum, Berlin). Arch. Geschwulstforsch., 22: 42-51(1963). (In German).

After a survey of various ways of treatment of thyroid hyperfunction and descriptions of their rates of cure, complications, and indications, the problems that accompany radioiodine treatment are thoroughly described. Observations of the blood electrophoresis findings in 28 patients who were treated with ^{131}I because of hyperthyroidism showed no increases in pathological findings when results from samples taken one week before, and one week after ^{131}I treatment were compared. Instead, there was a trend toward more normal values after treatment. The levels of blood protein fractions after various doses of ^{131}I showed a more definite trend toward normal after the higher doses. The results indicated no evidence to suggest any acute irradiation injury of liver that accompanied or followed ^{131}I therapy. The protein alterations observed in blood can be explained as an early normalization of thyroid function, and thus an associated improvement in thyroid and hepatic function. (BBB)

14702 SIGNIFICANCE OF THE STRATUM CORNEUM IN LIGHT REACTIONS OF THE HUMAN SKIN. Tronnier, Hagen (Univ., Tuebingen, Ger.). Strahlentherapie, 132: 128-34(Jan. 1967). (In German).

Investigations by Miescher have shown that the stratum corneum plays mainly the role of a filter in uv produced erythema. It is not so much considered as a "reservoir" for the initial events of erythema inducing substances which are produced or released under uv irradiation. Several recent results, however, cast doubt on the sole filter effect of the stratum corneum. In several experiments, concerning the determination of the erythema threshold value as well as of the degree of the erythema, it could be shown that the erythema depends very little on the stratum corneum and its thickness. Swelling of the stratum corneum intensifies the erythema due to better transportation of the erythema-inducing substances; drying of the stratum corneum has little effect on the threshold value; while a delayed onset of the erythema was observed. Using a W/O-emulsion, a less intense erythema was observed. An extraction of erythema-inducing substances into the emulsion might be an explanation, but further experiments have to be done to prove this hypothesis. (auth)

14703 THE ROLE OF RADIATION THERAPY IN TODAY'S MANAGEMENT OF INVASIVE CARCINOMA OF THE URINARY BLADDER. Vuksanovic, Mario (Jackson Memorial Hospital, Miami, Fla.). Ind. Med. Surg., 35: 578-9(July 1966).

Most urinary bladder carcinomas are sufficiently radiosensitive to be radiocurable by use of an appropriate radiotherapy technique. In the past the major technical problem consisted of delivering the required amount of energy to the deeply situated tumors by a variety of interstitial and intracavitary techniques. With high voltage apparatuses and isotopes capable of delivering adequate amounts of energy, the use of radiation for treating malignant disease of the urinary bladder has increased. This report considers 100 cases of invasive urinary bladder cancer treated by various radiation techniques, mostly megavoltage irradiation with an external teletherapy beam. The interstitial techniques frequently used in the past have been abandoned, except for the early, single lesion. So-called radical external irradiation of the tumor of the urinary bladder, to be successful, necessitates team work and close cooperation between the urologist and radiotherapist. The patency of the urinary tract and control of anemia and urinary tract infection are the absolute and essential prerequisites for successful treatment and cure. Morbidity may result from injudicious irradiation of the surrounding radiovulnerable structures, and the range of complications following radical radiotherapy must be acceptable. (BBB)

14704 DETECTION OF HEPATIC METASTASES BY MEANS OF ^{131}I ADMINISTERED RECTALLY: PRELIMINARY NOTE. Huys, J.; Van Vaerenbergh, P. M. (Univ., Ghent). Presse Med., 74: 1605-6(June 18, 1966). (In French).

No method now exists for early detection of tumor metastatic to liver in a high percentage of cases. A simple diagnostic test employing a radioisotope was developed to fill this need, that is, for detection of secondary liver tumor masses <2 cm in dia. In the method described, 50 μCi of ^{131}I, as NaI dissolved in 10 ml water, is injected intrarectally. A scintillation counter, equipped with a ratemeter and recorder, is placed over the abdomen to register impulses from ^{131}I in the liver. Normal liver and tumor-infiltrated liver gave different patterns of ^{131}I equilibration in the liver. In normal cases, a plateau of ^{131}I counts in the liver was reached in <5 min, while in the presence of liver metastases equilibration was not reached until after 20 min. There was very little overlap between normal and pathologic cases. It is concluded that this simple test is useful for detection of early liver metastases. (BBB)

Radiation Effects on Animals

Refer also to abstracts 14525, 14529, 14536, 14538, 14549, 14603, 14610, 14630, 14670, 14686, 14689, and 14703.

14705 (AD-644116) RADIATION RESISTANCE OF LONG-LIVED LYMPHOCYTES AND PLASMA CELLS IN MOUSE AND RAT LYMPH NODES. Miller III, J. J.; Cole, L. J. (Naval Radiological Defense Lab., San Francisco, Calif.). Sept. 23, 1966. 22p. (USNRDL-TR-1074). CFSTI $3.00 cy, $0.65 mn.

Rats and mice were given a secondary immunological stimulus with TAB vaccine and then were given twice daily injections of tritiated thymidine for 4 days into the hind foot pad. Thirty days later the mice were exposed to 850 RAD, 500 RAD, or were left nonirradiated and the rats were exposed to 850 RAD or left nonirradiated. Despite a marked, generalized destruction of lymphocytes, the aortic nodes of the mice and the popliteal nodes of the rats had larger values for percent of small lymphocytes labeled in the period immediately following irradiation than did the nodes from the nonirradiated control animals. The mean grain counts of the labeled small lymphocytes from irradiated animals were equal to or larger than those from nonirradiated animals. These results are interpreted as demonstrating a relative radio-resistance of long-lived, lymph node lymphocytes. Large numbers of persistently labeled plasma cells were also found in lymph nodes after irradiation. No difference could be found in the numbers or distribution of labeled plasma cells in lymph nodes from irradiated mice compared to lymph nodes from nonirradiated mice. There may have been a loss of a small proportion of the long-lived plasma cells present in the rat lymph nodes. We believe the ability of plasma cells to survive irradiation explains the radio-resistance of established antibody production. (auth)

14706 (BNWL-280, pp 17-18) COCARCINOGENIC EFFECTS OF CHEMICALS AND RADIATION. Mahlum, D. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Female Charles River CD rats were more susceptible to induction of liver tumors by dimethylaminoazobenzene (DAB) than were males. The injection of $^{144}Ce-^{144}Pr$ appeared to increase the susceptibility of the female to DAB carcinogenesis. (auth)

14707 (BNWL-280, pp 19-22) RADIATION AND DDT EFFECTS IN FLOUR BEETLES. Erdman, H. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Modification of fitness parameters of homogenic populations singly or doubly stressed with x radiation and DDT were specific for species and strains of flour beetles (Tribolium). (auth)

14708 (BNWL-280, pp 10-11) ULTRASTRUCTURAL STUDY OF INTESTINAL RADIATION DAMAGE. Mahony, T. D.; Berlin, J. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The intestinal mucosa of bile duct cannulated, x irradiated rats was compared with that from rats that were irradiated only. Ultrastructural differences were noted in the columnar cells that might indicate an action of bile and/or radiation on their secretory activity. (auth)

14709 (BNWL-280, pp 13-14) LATE EFFECTS OF SKIN IRRADIATION. Ragan, H. A.; Clarke, W. J.; Bustad, L. K. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Skin lesions produced by beta burns in sheep and swine 10 years ago have not changed in gross appearance during the past few years. A metastasizing fibrosarcoma and keratoacanthoma developed in a 10-year-old sheep at skin sites exposed to 16,000 rads from a ^{32}P source 9 years ago. (auth)

14710 (BNWL-280, pp 24-8) EFFECTS OF ^{90}Sr IN MINIATURE SWINE. Palotay, J. L.; Ragan, H. A.; Clarke, W. J.; Vogt, Glenda S.; Beamer, J. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Studies were continued on the biological effects of daily ingestion of ^{90}Sr by miniature swine fed 1 to 3100 μCi/day. Currently 281 animals are alive and being maintained for lifetime observation and study. In animals over 2 years of age, two cases of neoplasia of hematopoietic tissue have been observed in the 25 μCi/day group, and 15 in the 125 μCi/day group. Fifteen cases of hematopoietic neoplasms or extramedullary myelopoiesis have been diagnosed in F_1 generation of offspring less than 6 months old in the 625 μCi/day group. (auth)

14711 (BNWL-280, pp 38-9) EFFECT OF INGESTED RADIOACTIVE PARTICLES IN THE RAT. Sullivan, M. F.; Mahony, T. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Insoluble particles of 1 mm diameter, containing about 1 mCi ^{89}Sr, produced discrete focal lesions during their passage through the gastrointestinal tract of the rat. (auth)

14712 (BNWL-280, pp 39-40) EFFECTS OF RADIOACTIVE PARTICLES ON THE SKIN AND GASTRIC MUCOSA OF MINIATURE SWINE. McKenney, J. R.; Ragan, H. A.; Shannon, R. O. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The gastric mucosa and the skin of Hanford miniature swine were exposed to 1 mm particles labeled with ^{89}Sr. No appreciable damage was observed in the gastric mucosa after exposures of 1 or 4 hr (13,000 or 52,000 R surface dose). Skin exposures of the same duration resulted in lesions that healed slowly. This apparent difference in sensitivity was probably due to technical difficulties encountered in the intragastric exposures. (auth)

14713 (BNWL-280, pp 122-3) POSITIVE PHOTOTAXIS IN FIRST INSTAR CADDIS LARVAE. Coutant, C. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Positive phototaxis was observed in newly hatched Hydropsyche cockerelli larvae despite a recognized negative phototaxis in later larval instars. (auth)

14714 ON THE POSSIBILITY OF ELECTRON MICROSCOPY DETECTION OF CELLULAR LESIONS DUE TO RADIATION. Klug, H. (Univ., Charite, Berlin). Deut. Gesundsheitsw., 20: 2203-9(1965). (In German).

The author emphasizes the importance of electron microscopy for detecting the evaluating cellular radiation injuries. Results obtained by numerous investigators are reviewed. These include studies of a wide range of cellular elements from many tissues of experimental animals that have been made at irradiation levels of 100 to 100,000 R. Effects of external radiation from x ray, ^{60}Co, and ^{210}Po are also reported. Effects of high energy protons are reported. The findings indicate that radioinduced morphological changes are frequently observed in the cytoplasmic structures of tissues, such as the mitochondria and endoplasmic reticulum, while intranuclear structures are most affected in lymphocytes and cells of the cerebellum. Various types of cells differ as to the cytoplasmic organelles affected by irradiation, and in their radiosensitivity. Evidence of radiation injury varies with the cell component. Cell membranes show rupture and necrolysis after cell death; mitochondria (sarcosomes) show swelling, vacuolization shortening of the cristae, and degeneration; Golgi apparatus (dictyosomes) show vacuolar expansion of the terminal interlamellar spaces, and vesicular degeneration; the endoplasmic reticulum shows similar effects, with fragmentation and detachment of ribosomes; the ground plasma shows vacuolization; and the cell nucleus shows generalized thickening of the karyoplasm with appearance of membrane structures and microfibrils, and enlargement of the nucleolus. No characteristic changes are observed in the centrosome. At least some of the changes seen seem to result from disturbances of osmoregulation and electrolyte changes. These may be mechanisms of reaction that are common to many or most of the different structural changes observed. References cited, 91. (BBB)

14715 EFFECTS OF X-IRRADIATION ON THE ADRENAL GLANDS OF IMMATURE RATS. Wall, P. G. (Univ. of Birmingham, Eng.). J. Endocrinol., 34: 69-80(Jan. 1966).

This investigation was designed to study the effect of various doses of x rays on the adrenal glands in vivo, with particular emphasis on the questions of whether localized x irradiation influences the postnatal development of the adrenal glands and, if so, to what extent is the effect age-dependent; and whether prepubertal irradiation affects the ability of one adrenal gland to undergo compensatory hypertrophy after the removal of the other. Doses of 400 to 1800 R were given to male rats 3 to 36 days postpartum. Localized irradiation of the adrenal glands of rats aged 3 to 36 days inhibited subsequent gain in body weight and in the growth of the adrenal glands, the degree of retardation depending on the dose applied. The cortico-medullary ratio was essentially the same in irradiated and control animals. As judged by compensatory

hypertrophy of one adrenal gland after the removal of the other, adrenal function was unaffected by irradiation within the range of doses and ages investigated. This study revealed an apparent paradox. The adrenal glands of young rats, which showed morphological changes after irradiation, were seemingly radioresistant. In contrast, the adrenal glands of adult animals are claimed to be functionally radiosensitive. The test of adrenal function used here was the growth response of one gland to increase levels of endogenous adrenocorticotrophic hormone (ACTH) induced by the removal of the other gland. However, this method may be less sensitive than other tests (e.g. measurements of corticosteroids in adrenal venous blood). Further studies are required to resolve the paradoxical results. Although the degree of compensatory adrenal hypertrophy was unaffected by irradiation, the mechanism underlying it may have been. In the control rats, the cells of the zona fasciculata enlarged only a little after unilateral adrenalectomy. In adrenal glands treated with 1800 R, on the other hand, the cells in the zona fasciculata were clearly enlarged, an effect more marked in animals subjected to both adrenal irradiation and unilateral adrenalectomy. (BBB)

14716 DELAYED MYELINATION OF NEONATAL RAT SPINAL CORD INDUCED BY X-IRRADIATION. Gilmore, Shirley Ann (Univ. of Arkansas, Little Rock). Neurology, 16: 749-53(Aug. 1966).

Lumbar spinal cords of 3-day-old rats were irradiated with a total dose of 2000 R of x rays. Spinal cords from rats killed from 11 through 15 days following irradiation showed decreased amounts of myelin and neuroglia. Irradiated neurons revealed no observable changes and were indistinguishable from those in control sections. Beginning at 17 days, and occasionally at 15 days after irradiation, increased quantities of neuroglia and myelin were noted in the irradiated areas. These increases represent the conditions noted in the spinal cord by 19 days following irradiation. At 23 days following irradiation the amount of myelin begins to increase rapidly, and the spinal cord appeared to be normal by 27 days after irradiation. There were no obvious differences in myelin between the irradiated and control spinal cords, and the quantity of neuroglia also appeared to be normal. Spinal cords from irradiated rats killed between day 27 and the termination of the experiment at 33 days following irradiation appeared to be normal. The results confirm that radiation can retard myelinogenesis, and that this retardation is only temporary. (BBB)

14717 OBSERVATIONS OF THE EPIDERMAL ULTRASTRUCTURE AND THE SUBEPIDERMAL NERVES BEFORE AND AFTER X IRRADIATION. PART I. Hagen, E.; Werner, S. (Univ., Bonn). Arch. Klin. Exp. Dermatol., 225: 306-27(1966). (In German).

The autonomic and the cerebrospinal nervous systems both are involved in the nerve supply to the skin. Observations with the light microscope have shown that there is a basic difference in the innervation of haired and nonhairy skin in humans. Only the unhaired skin has a series of nerve endings such as Meissner, Pacini, Krause, or Ruffini bodies. These can be differentiated from one another only in terms of their functions. Hirsute skin contains a network of nerves surrounding the epidermal hair root sheaths, forming a receptor organ where autonomic fibres are present in large numbers. Hirsute and nonhairy portions of skin in dogs were irradiated with 3000 R given at a rate of 200 R daily for 15 days, and portions were excised at 21 days, 3 months, or 1 yr after irradiation. Monkey skin was irradiated with 2000 R given at a rate of 200 R daily for 10 days, and portions were excised at 16 days and at 6 months after irradiation. Monkey skin was irradiated also with 20 or 100 R, given at a rate of 100 R/hr. Skin samples were taken at 1 or 1½ hr after irradiation. Electron microscope studies of the samples confirmed the existence of intraepithelial nerves in the epidermis of irradiated and nonirradiated skin. X-ray damage of the epithelium consisted of proliferation of desmosomes and tono fibrils, and dilation of the intercellular spaces. Mitoses were observed. In the subepidermal nerve plexus, after irradiation the axones were distended and the ultrastructure of the Schwann cells was altered. References cited, 79. (BBB)

14718 EXTRACORPOREAL IRRADIATION OF THE BLOOD. Schiffer, L. M.; Chanana, A. D.; Cronkite, E. P.; Greenberg, M. L.; Joel, D. D.; Schnappauf, H.; Stryckmans, P. A. (Brookhaven National Lab., Upton, N. Y.). Seminars Hematol., 3: 154-67(Apr. 1966).

This review (with 31 references) considers advances in extracorporeal irradiation of the blood (ECIB). Initial experiments upon calves were done with continuous ECIB, using Tygon tubing and venovenous shunts. It was difficult to keep these operating satisfactorily for more than 72 hr because of mechanical damage to erythrocytes caused by pumps and bleeding induced by continuous heparinization. The introduction of the Quinton–Schribner Teflon–Silastic chronic arteriovenous shunts for renal hemodialysis has made prolonged and repetitive sessions of ECIB practical. The underlying principle of ECIB is to utilize the difference between the radiosensitivity of the lymphocyte and the radioresistance of the erythrocyte. ECIB of the blood not only produces significant and sustained depletion of peripheral blood lymphocytes but also results in lymphocyte depletion of organs. Studies have now reached the stage at which ECIB can be safely applied to prevent or reverse rejection of human organs after homotransplantation. ECIB has significant potential usefulness in this field, but full evaluation remains to be performed. Limited studies of the treatment potentials of ECIB in acute myelocytic leukemia indicate that it may be useful in selected cases, but it is not yet recommended for general use, especially as the sole treatment. Further studies of its usefulness in chronic lymphocytic and chronic myelocytic leukemia are indicated because of favorable results in a few patients. (BBB)

14719 EFFECT OF RADIATION ON VARIABILITY OF WEIGHTS IN PEROMYSCUS POLIONOTUS. Williams, R. G.; Carmon, J. L. (Univ. of Georgia, Athens). Bull. Ga. Acad. Sci., 24: 93-9(Sept. 1966).

Growth data were collected on 1532 animals from 440 litters produced by the first and second generation offspring of wild-trapped mice, P. polionotus. The male offspring were randomly divided into 3 groups each receiving one of the following treatments of whole-body γ-ray exposure: 0 R, 100 R, and 200 R. The maternal effect of the dams of the 3 treatments was predominant for the 0-, 7-, and 14-day weight periods. For the 21-day weight, the maternal effect in the control group dropped to about half the value of either irradiated group. The maternal effects decreased from an average for all groups of 64% at 21 days to 19.8% of the total variation for the 45-day weight. Radiation brought about an increase in the importance of maternal effects for the 7-, 14-, and 21-day weights. The genetic, maternal, and random effects indicated that both maternal and genetic effects are important in determining birth weight of P. polionotus. Any maternal effects of the dam for birth weight should be considered as prenatal in that the individual has not been subjected to any postnatal effects at this time. The average estimates for all groups of maternal effects for birth weight of 59% and genetic effects of 15% indicated that the prenatal influence upon birth weight seems to be large as compared to the genetic influence. Previous work has shown that the characteristics of growth and milk production are sensitive to radiation effects. In lines of mice where only the males are treated, much of the genetic decrement is recessive. (BBB)

14720 SOME OBSERVATIONS ON STEREOTAXIC RADIOFREQUENCY AND PROTON BEAM LESIONS. Sarby, B.; Wennerstrand, J.; del Corral-Gutierrez, J. Confin. Neurol., 26: 133(1965).

Investigations were performed to standardize stereotaxic thermal and fast particle lesions in the brain of cats and goats. Thermal lesions were studied through preliminary model experiments, where different electrode lengths, electrode distances, voltages, and times of exposure were used. The shape and size of the lesions were standardized in relation to the supplied electrical energy, determined by the voltage between the electrodes, the a-c resistance, and coagulation time. In some experiments a gel with the same electrical and mechanical properties as the grey matter in the cat was used. These results were then applied to experiments in cats, lesions being produced in grey and white matter. From these experiments information was gained on both the physical and biological factors involved, and their effect on the shape and size of the lesions. The results were evaluated through the use of a photographic reconstruction method. Preliminary observations were made on chronic lesions produced in goats by means of crossfire irradiation with high-energy protons. (BBB)

14721 THE EFFECTS OF X-IRRADIATION ON THE DEVELOPMENT OF THE CEREBRAL CORTEX. Berry, M. (Univ. of Birmingham, Eng.); Eayrs, J. T. J. Anat., 100: 707-22(Oct. 1966).

Effects of x irradiation during fetal life on the histogenesis of the rat cerebral cortex, and on the morphology of its constituent neurons, were studied. Irradiation on the 19th day of gestation resulted in widespread destruction of cortical cells. Cells which survived were contained in a band subjacent to the zonal layer and in occasional islets in the germinal and mantle layers. This damage was apparent 12 hr after irradiation but 24 hr later there were signs of recovery and differentiation of surviving neutrons, though the ependymal layer had apparently lost its capacity to contribute further normal histogenesis. The configuration of neutrons contained in layers corresponding to Vb, VIa and VIb of the mature rats was abnormal, the nature and degree of abnormality depending upon the age at irradiation. The sites of origin of dendrites and their orientation were altered and many

were stunted in growth. The pattern of distribution of dendrites, measured in terms of dendritic density at successive distances from the perikaryon, was little affected by irradiation on the 19th and 21st day of gestation, though in general the number of primary dendrites and amount of branching was less than normal while the rate of decay of the mean dendritic field was greater, reflecting a reduced capacity to make connections with incoming axons. (BBB)

14722 CHANGES IN THE VILLOUS PATTERN OF THE HUMAN JEJUNUM ASSOCIATED WITH HEAVY RADIATION DAMAGE. Wiernik, George (Churchill Hospital, Oxford). Gut, 7: 149-53(Apr. 1966).

Serial biopsies of jejunal mucosa from 6 patients who were undergoing ^{60}Co radiotherapy for gastric cancer were examined microscopically. Following irradiation, mitotic activity in the crypts diminished and the number of epithelial cells lining both the crypt and covering the villus decreased. The villi became unrecognizable by day 11 so that the mucosa looked flat. The histological appearances showed that not only was the villous structure lost but the crypts also were so severely damaged that no normal structure could be recognized in them. When the mucosa recovered from the radiation damage, the villous pattern that had formed by day 53 was seen as convoluted and folded villous ridges and histological sections show that these broad villous structures span several crypts of normal appearance. These findings show that the mucosa is capable of changing rapidly from one type of pattern to another. These changes are probably directly linked with alterations in the epithelial cell system that forms the lining of the villus and the crypt. (BBB)

14723 EFFECTS OF GAMMA RADIATION ON RHYZOPERTHA DOMINICA, SITOPHILUS ORYZAE, TRIBOLIUM CONFUSUM, AND LASIODERMA SERRICORNE. Tilton, Elvin W.; Burkholder, Wendell E.; Cogburn, Robert R. (Stored-Product Insects Research Branch, Savannah, Ga.). J. Econ. Entomol., 59: 1363-8 (Dec. 1966).

Attempts were made to determine the dose necessary for commercial applications of γ radiation, by determining the min effective dose required to obtain sterility of the most resistant age and metamorphic stage of some species found in various stored products. Lesser grain borers, R. dominica; confused flour beetles, T. confusum; rice weevils, S. oryzae; and cigarette beetles, L. serricorne, were exposed to various levels of γ radiation from a ^{60}Co source. All 4 metamorphic states of each insect were used, Doses were 13.2, 17.5, 25, 45, and 100 kRad and, on all insects except the lesser grain borer, a fractionated dosage of 13.2 kRad repeated 5 times at hourly intervals was also used. The dose rate for all treatment levels was about 330 kRad/hr. In all species the adults were the most tolerant, followed by the pupae, then the larvae, and then the eggs. No dose used was high enough to produce immediate complete mortality of all species. All 4 species were sterilized by γ radiation in a single continuous dose of 25 kRad or more. (BBB)

14724 RADIATION DAMAGE AND REPAIR IN THE HUMAN JEJUNAL MUCOSA. Wiernik, George (St. Thomas's Hospital, London). J. Pathol. Bacteriol., 91: 389-94(1966).

Histologic examination of the jejunal mucosa was made prior to, during, and subsequent to therapeutic irradiation in cases in which the radiation damage was severe but not excessive. The study was confined to the radiation effect upon the architecture of the mucosa and the epithelium of the villi and crypts; changes in the lamina propria and the vascular and connective tissues were not examined. Histological appearance of serial biopsies were not found to be as accurate a guide to radiation damage as were epithelial cell row counts. One day after a single large dose of irradiation there was a diminution in mitotic activity, but the crypt epithelial cells showed evidence of radiation damage only on the 3rd day. Increasing damage was noted in the crypts up to the 6th day, though a transient rise in mitosis was noted on the 3rd day which was considered to represent abortive mitotic recovery. A sustained rise in mitotic activity started about the 8th day and was followed on the 10th day by repopulation of the crypt which led to an increase in the villous epithelial cells 24-48 hr later. This was followed by the overshoot phenomenon in both the crypt and the villous structures. When radiation damage was more severe, either crypt or villous structures became unrecognizable, and this was followed by a change in architecture that was not noted after moderate radiation damage. The changes in mucosal pattern were associated with changes in the epithelial cell population. (BBB)

14725 CHANGES IN KIDNEY TISSUE FOLLOWING DIRECTED HIGH-DOSAGE X IRRADIATION. Mohr, H. J.; Morgenroth, K. (Univ., Muenster, Ger.). Verhandl. Deut. Ges. Pathol., 49: 206-12(1965). (In German).

The right kidney of guinea pigs was subjected to a 3000-R skin dose of 50-kv x rays (single or 5 600-R doses) and 2 to 80 days later was examined by light and electron microscopy. Such a single dose of radiation produced only damage to the tubular epithelium, and no structural changes could be demonstrated in the glomeruli. If the same total dose of radiation was given in 5 fractions, apart from the tubular changes, considerable damage of the glomeruli was produced, the latter being manifested as increasing swelling of the endothelium of the capillary loops, with narrowing and partial closing of the loop lumen, and consequent depolymerization of the basement membrane polysaccharide. Tubular epithelial changes dominated the picture after both single and fractionated irradiation, whereas the glomerular lesions only appeared after the tubular epithlial changes were fully developed. The concept that radiation damage to tubules occurs as a secondary effect and that it is due to vascular or glomerular causes cannot be accepted any longer. The pathogenesis of radiation damage to the nephron is, in the initial phase, essentially due to the primary damage to and the destruction of the mitochondria and of the endoplasmic reticulum of the cell. The tubular and the glomerular changes arise independently and are separated by time intervals from one another. The parenchymal lesions which produce the shrunken kidney are affected by the glomerular loop changes only later in their course. (BBB)

14726 ULTRASTRUCTURAL AND CYTOCHEMICAL STUDIES ON KARYOLYTIC BODIES IN THE EPITHELIUM OF THE DUODENAL CRYPTS OF WHOLE-BODY X-IRRADIATED MICE. Hugon, J.; Borgers, M. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Lab. Invest., 15: 1528-43(Oct. 1966).

Adult mice of the BALB/c strain were irradiated with 1350 R of x rays and sacrificed 1, 2, 3, 6, and 24 hr after irradiation. In the first hours after irradiation the epithelium of the duodenal crypts showed an increasing number of karyolytic bodies. Ultrastructural study of these formations revealed that they consist partly of autophagic vacuoles and partly of phagosomes. The former developed in the damaged stem cells by secluding a necrotic area from the rest of the cytoplasm. The phagosomes formed by an engulfment of degenerative leukocytes and dying stem cells. Acid phosphatase and thiamine pyrophosphatase activities were demonstrated in these inclusion bodies. In experiments with protein-deficient animals, after irradiation, the appearance of karyolytic bodies was greatly delayed. Apparently the irradiated crypt cells develop a new distribution of hydrolytic enzymes, which degrade the injured organites. These observations provide an explanation of the previous observation that aseptic autolysis is more rapid in irradiated crypts than in those of controls. Moreover, in nonirradiated animals, the villus autolyzes first. It appears that this fast aseptic autolysis of the crypt is due to its high content in hydrolytic enzymes after irradiation. (BBB)

14727 THE IRRADIATED HAMSTER TEST: A NEW METHOD OF DONOR SELECTION FOR HOMOTRANSPLANTATION IN MAN. Streilein, J. Wayne; Hildreth, E. A.; Ramseier, H.; Kornblum, J. (Univ. of Pennsylvania, Philadelphia). Ann. Internal Med., 65: 511-20(Sept. 1966).

Homologous rodent lymphoid cell mixtures of binary orgin (from 2 individuals) evoke delayed reactions when injected intracutaneously in irradiated hamsters. The intensities of these reactions are related to the degree of immunogenetic disparity between the cell donors as revealed by the survival times of skin homografts exchanged between members of the strains concerned. These observations suggested that, if mixtures of human lymphoid cells behave in a similar manner when injected intracutaneously into irradiated hamsters, their reactions might furnish the basis of a means of donor selection for homotransplantation in man. Albino hamsters of the isogenic MHA strain were given a lethal dose of 1500 R whole-body irradiation. Human lymph node cells were suspended in balanced salt solution and injected (in aliquots of 10 to 20 million cells/0.1 ml volumes from single donors) into the skin of irradiated hamsters. These suspensions of unitary origin (1 donor) consistently failed to elicit significant skin reactions. When mixtures of lymphocytes from pairs of identical twins were injected into the skins of irradiated hamsters, there was no appreciable difference in intensity between the lesions thus induced and lesions evoked by injections of cell suspensions of unitary origin. However, when genetically disparate cell suspensions, prepared from lymph nodes removed from random donors, were mixed and similarly injected, cutaneous lesions developed which were identical to those in which homologous mixtures of rodent lymphoid cells were used. Peripheral blood lymphocyte suspensions from two unrelated individuals injected into the skins of irradiated hamsters caused an inflammatory lesion similar to that induced by the human lymph node cell mixtures. Thus, this test provides a positive correlation between theo-

retical histo-incompatibility and the intensity of skin reactions induced by lymphocyte mixtures from any given pair. A critical experiment in which results of this test were matched against the survival of skin homografts to indicate degree of histocompatibility demonstrated that the irradiated hamster test was, in 3 of 5 instances, capable of selecting relatively compatible pairs of unrelated humans. (BBB)

14728 INVAGINATED MITOCHONDRIA IN THE LIVER CELLS OF MOUSE EMBRYOS AFTER X IRRADIATION. Pipan, Nada (Univ. of Ljubljana, Yugoslavia). Z. Zellforsch. Mikroskop. Anat., 73: 534-9(1966). (In German).

An electron microscopic study was conducted on mitochrondria in the developing liver. The livers of 13-, 15, and 17-day-old mouse embryos x irradiated with 1200, 1500, 1700, or 1800 R were examined 2 or 3 days after irradiation. The liver cells of the 13- and 15-day-old embryos showed swollen mitochondria, the surface of which was often increased by one or more invaginations. The surrounding cytoplasm protruded into the mitochondria and was occasionally completely enclosed. Often these cytoplasmic protrusions contained concentric membranous structures. These findings are discussed by considering the pathologic changes in liver mitochondria described by other authors. Such fine structural changes as observed here have also been seen in liver injured by other noxious agents. (BBB)

14729 STUDY OF THE EFFECT OF IRRADIATION ON REPAIR OF BONE FRACTURES BY A TISSUE CULTURE METHOD. Takase, Buhei; Yamasaki, Yasuo; Yasumoto, Saburo; Nunoya, Takesi; Miyasawa, Yoich (Kanesawa Univ., Japan). Nippon Seikei Geka Gakkai Zasshi, 38: 539-41(Sept. 1964). (In Japanese).

Bone fractures were produced in chicken embryos and the effect of x irradiation on their repair was studied histologically and histochemically. The femur of the chicken embryo at 9 days after hatching was removed, fractured by means of a thin knife and placed in a roller tube with 2 ml culture medium (pH 7.4–7.8) containing 80% Morgan, Morton, and Parker's No. 199 solution and 20% bovine serum. The bones were incubated for 1, 2, 3, 4, 5, 6, 7, 9, 11, and 14 days at 37°C after irradiation with doses of 300, 500, 800, 1000, 1200, 1500, and 2000 R. The femurs were then fixed in cold acetone, stained with hematoxylin-eosin, and examined histochemically for alkaline phosphatase. Irradiation with 300 R resulted in the disappearance of callus cells, whereas the 800- and 1000-R groups showed less injury to these cells. However, in the 1500-R group the changes in these cells at the fracture surface were again marked. By 5 to 9 days after incubation the bone fracture was repaired and at the 9th day the bone showed max repair, with the fractured zone rejoined completely. Up to 2 days incubation no change in alkaline phosphatase activity was observed in irradiation groups, but a positive reaction in some cells was seen after 3 to 9 days incubation. The alkaline phosphatase activity of the fractured bone in 300- and 500-R groups was weaker than in the control group. However, in the 1000-R group its activity was stronger than in the control group. (BBB)

14730 EFFECTS OF GERM-FREE ENVIRONMENT, BURSECTOMY, AND IRRADIATION ON THE PRODUCTION OF NATURAL AND IMMUNE OPSONINS IN YOUNG CHICKS. Solomon, J. B. (Univ. of Adelaide). Immunology, 11: 97-102 (Aug. 1966).

The opsonins for goat erythrocytes present in the circulation of normal chicks after the decline of maternal antibody may be natural antibodies. Natural antibodies for goat erythrocytes are detectable in normal chick serum from 7 days of age. Attempts were made to suppress the active synthesis of both natural and immune antibody by keeping the chicks in a germ-free environment, and by bursectomy and irradiation. Whole-body irradiation was performed with a ^{60}Co source. The various immunosuppressive treatments in earlier life failed to depress the level of opsonins for goat erythrocytes during the first 2 weeks of age. A germ-free environment did not affect phagocytosis. The slower clearance of goat erythrocytes from the circulation of chemically bursectomized or γ-irradiated chicks was in proportion to the degree of runting. Weight-adjusted doses of goat cells given to such runted chicks were cleared at the same rate as larger doses in control birds. No specific suppression of opsonin level occurred in the absence of runting. Although the production of immune antibody was depressed by bursectomy in older chicks or by 600-R irradiation of 19-day-old embryos immunized in mid-embryonic life, there was no such inhibition of the production of natural opsonins. (BBB)

14731 PRE-OPERATIVE RADIATION IN HEAD AND NECK CANCER: PRELIMINARY REPORT. Skolnik, E. M.; Tenta, L. T.; Comito, J. N.; Jerome, D. L. (Univ. of Illinois, Chicago). Ann. Otol., Rhinol., Laryngol., 75: 336-55(June 1966).

Complications are reported among 79 patients who received supravoltage x-ray therapy before surgical removal of cancers of the head and neck. The histologic changes that occurred after irradiation therapy are noted. In no case was there complete eradication of the tumor either in the primary site or in the metastatic lymph node following irradiation therapy. The disabling complications of pharyngocutaneous fistulae and massive carotid artery hemorrhage were studied in particular. Pharyngocutaneous fistula evident beyond the 14th postoperative day occurred in 33 of the 63 cases studied (52%). The claim that postoperative morbidity is not substantially increased by irradiation was not supported by surgical experience. A course of irradiation, involving a dose averaging 5000 to 6000 rad delivered to a vascular area such as the neck, carries the possibility of some degree of anemia. Therefore, during the postirradiation phase the general healing powers of the tissues are inevitably impaired. At every level, the normal vascular bed and its innervation are, therefore, impaired to a greater or lesser extent by the developing fibrosis and as the blood flow from one level to another is reduced. There may also be other less identifiable and perhaps more profound changes in the irradiated tissues whereby cell growth and reparative powers are affected, even when the blood supply appears adequate. (TSS)

14732 RADIOSENSITIVITY OF LEUKEMIC AND NONLEUKEMIC LYMPHOCYTES. Johnson, Ralph E. (National Cancer Inst., Bethesda, Md.). Cancer Res., 27: 39-42(Jan. 1967).

Ten patients with chronic lymphocytic leukemia and 13 patients with nonleukemic diagnoses have been treated with total body x radiation in small divided doses. The response of the hemoglobin count, platelet count, and absolute neutrophil count was similar for both groups of patients. The absolute lymphocyte counts were markedly reduced in the leukemic patients as compared to the nonleukemic patients. Similar changes were observed in the bone marrow. The fractionated dosage schedules provided a high therapeutic ratio and resulted in an apparently normal or nearly normal morphologic state in the peripheral blood and bone marrow of several patients with chronic lymphocytic leukemia. (auth)

14733 LYMPHOID TUMOR INDUCTION BY MOUSE THYMOCYTES INFECTED IN VITRO WITH RADIATION LEUKEMIA VIRUS. Lieberman, Miriam; Kaplan, Henry S. (Stanford Univ., Palo Alto, Calif.). Nat. Cancer Inst. Monogr., No. 22, 549-57 (Sept. 1966).

The interaction between thymic cells and the radiation leukemia virus (RLV), a leukemogenic virus extracted from radiogenic lymphomas of strain C57BL mice, was studied. By injection of lymphoid cells from donor mice of one parental strain, after RLV infection in vitro, into thymus grafts from donors of the other parental strain growing in thymectomized, irradiated F_1 hybrid hosts, it was possible to establish that thymic lymphoid cells are the targets for neoplastic transformation by RLV and to assess the influence of several parameters on tumor incidence and transplantation behavior. Mice were given 600-R whole-body irradiation, in 3 weekly doses of 200 R; they were 6 weeks old at the time of first exposure, which took place 1 week after total thymectomy. On the basis of transplantation behavior, the results showed that the tumors resulting from direct RLV injection were of graft-donor or, less often, of host derivation, as were those which developed after injection of peritoneal cells infected with RLV in vitro, with rare exceptions. In contrast, most of the tumors resulting from the injection of neonatal thymocytes, infected with RLV in vitro, were of cell-donor origin. Such tumors must have developed from the injected thymic lymphoid cells, which are thus identified as the target cells for the neoplastic transformation induced by the virus. It was also established, however, that host genotype and thymic graft viability exert a strong influence on tumor incidence. The significance and interaction of other factors in determining susceptibility to murine viral leukemogenesis should also be amenable to study with this experimental system. (BBB)

14734 BIOLOGICAL EFFECTS OF MICROWAVE RADIATION OF 24,000 MEGACYCLES. Deichmann, William B. (Univ. of Miami, Coral Gables, Fa.). Arch. Toxikol., 22: 24-35(Apr. 1966).

Animal studies conducted with pulse-modulated magnetrons, operated at 24,000 Mcps or at a wavelength of 1.25 cm, demonstrated that microwave energy can cause severe local damage, as well as systemic effects related primarily to stimulation of the central nervous system, and death. Hyperpyrexia is prominent in animals exposed to harmful or lethal doses, but there is some indication that microwave energy, or a fraction of this energy, exerts its effect in some other form than heat. Possible nonthermal or athermal radiation effects are discussed. The electrocardiographic changes noted in the irradiated embryonic chick heart, and the fatalities induced by microwave radiation in rats with subnormal body temperatures, appear to require more than the conventional explanation. It is sug-

gested that consideration be given to modification of the human tolerance dose of 10 mW/cm². It is believed that this is important to discourage unrealistic and unjust claims of injury. The following factors are suggested as important for biological effects: wavelength; time (including the irradiation cycle rate); environmental conditions (air currents and temperature); and body area (whole-body exposure vs eyes, testes, or abdomen). (BBB)

14735 CANCER MORTALITY AMONG A GROUP OF UNDERGROUND METAL MINERS. Wagoner, Joseph K.; Miller, Robert E. (National Inst. of Health, Bethesda, Md.). New Engl. J. Med., 269: 284-9(Aug. 8, 1963).

A study of mortality among uranium miners of the Colorado Plateau has suggested more cancer of the respiratory tract than in the general white male population of the same region, radioactivity in the mines being the suspected carcinogenic agent. To explore the possibility that other mining exposures have played a part in the genesis of this cancer, the mortality among a group of metal miners in the United States who were occupationally exposed to relatively low levels of radioactivity was studied. Records were examined for 1759 miners who had completed a min of 15 yr of underground mining experience between 1937 and 1948. Comparisons made with the general white male population of the region showed a higher total mortality among the miners. When the mortality pattern was compared with that of the underground uranium miners, for causes of death other than accidents, the total deaths among the uranium miners no longer exceeded expectation, but the significant excess among metal miners still persisted. Because of the possibility that mining exposures other than radiation are involved in the genesis of respiratory cancer, studies of uranium miners should evaluate the role of their prior hard-rock mining experience. Mines in this study had atmospheric concentrations of radon in the range of 10 to 80 pCi/l, and concentrations of the associated daughter products varied from 10 to 20% of the minimum working level recommended. (BBB)

14736 RETINAL DAMAGE BY LIGHT IN RATS. Noell, Werner K.; Walker, Virgil S.; Kang, Bok Soon; Berman, Steven (State Univ. of New York, Buffalo). Invest. Ophthalmol., 5: 450-73(Oct. 1966).

Effects of intense flashes or continuous exposures of uv and visible light on the retina were examined histologically and by the electroretinogram (ERG). The retina of rats was affected irreversibly by intense light applied under certain experimental conditions. Irreversible reduction in ERG amplitudes and degeneration of visual cells and pigment epithelium indicated the severity of the damage. The effect was dependent upon the body (eye) temperature during exposure. Hyperthermia greatly accelerated and intensified the damaging action of radiation, and for this reason most experiments were performed at a high body temperature. At 104°F severe damage was produced with exposures to 5 to 10 μW/cm² of retina for 1 hr. The minimal damaging dose at a high temperature was about 1 μW/cm². The action spectrum of the damaging effect approximated that of visual excitation as measured by the ERG. Hooded (pigmented) animals were no more affected than albinos of different strains. Recovery in the dark from a just subliminally damaging dose of light at a high body temperature required about 24 hr and was preceded by a period of time during which the retina was sensitized to an additional dose. During or following exposure to light at a high body temperature visual cell and pigment epithelial damage developed about simultaneously and was first indicated by pyknosis and cell swelling followed rapidly by the dissolution of nuclei and cytoplasm. The crucial reaction in producing the damage was considered a dark-reaction initiated by light of an intensity that bleaches measurably rhodopsin. (BBB)

14737 STRUCTURE OF THE CORPUSCLE OF STANNIUS IN NORMAL AND RADIOTHYROIDECTOMIZED CHINOOK FINGERLINGS AND SPAWNING PACIFIC SALMON. Nadkarni, V. B. (Worcester Foundation for Experimental Biology, Shrewsbury, Mass.); Gorbman, Aubrey. Acta Zool., 47: 61-6(1966).

The histological structure of the corpuscle of Stannius of normal and radiothyroidectomized Chinook fingerlings, and two species of spawning Pacific salmon is described. Chinook fingerlings were radiothyroidectomized by immersing them in lake water containing ^{131}I (25 μCi/ml) for 8 days. Complete removal of the thyroid was ascertained by giving a tracer dose of ^{131}I and taking autoradiographs of the entire lower jaw 60 to 80 days after radiothyroidectomy. The corpuscles of Stannius were stained with hematoxylin-eosin, PAS, or Gomori's aldehyde fuchsin (AF) method. The corpuscles of Stannius were seen as round, oval, or often irregular bodies embedded in the dorsal or the dorsolateral part of the kidney. The number varied from 5 to 6, and the size also varied. Generally, one pair of the corpuscles was distinctly larger than the remaining ones. In the spawning salmon some of the corpuscles were larger, measuring up to 8 mm in dia and 3 mm in thickness. Most cells of the corpuscle were PAS-positive and also AF-positive, but a few were PAS-negative and AF-negative. There was no change in the histological picture of the corpuscle after radiothyroidectomy. Some of the spawning salmon exhibited central degeneration of the corpuscle. (BBB)

14738 RADIONECROSIS OF THE TEMPORAL BONE. Schuknecht, Harold F.; Karmody, Collin S. Laryngoscope, 76: 1416-28(Aug. 1966).

Histologic study was made of the temporal bones of two patients who developed osteonecrosis following x-irradiation for malignancy adjacent to, but not involving, the temporal bone. One patient died from otitic meningitis and the other showed the classic picture of osteoradionecrosis with secondary infection of the mastoid. The osteonecrosis of the temporal bone occurred 12 and 4 yr respectively after radiation therapy. The histopathological findings showed a slowly progressive aseptic osteonecrosis with reparative fibrosis, secondary otitis media, and mastoiditis. The findings in one case suggested that the annular ligament of the oval window as well as the basilar membrane, spiral ligament, and stria vascularis are most susceptible to irradiation injury; the organ of Corti and spiral ganglion appear to be resistant. In contrast to the soft tissue changes, irradiation damage to bone may take months or years to develop, depending upon the blood supply of the bone and on the pattern of irradiation. Single doses of 5000 R given to one focus of bone may cause immediate massive local necrosis. Even fractionated doses, however, given at sufficiently high intensity to a small field may result in bone necrosis that develops more insidiously. The presence of an osteolytic lesion in contiguity with the upper respiratory tract (e.g., middle ear) is potentially dangerous. Damage to the temporal bone associated with irradiation of the maxilla is rare. The temporal bone appears to be peculiarly susceptible to radionecrosis, the complications of which may be fatal. (TSS)

14739 ENVIRONMENTAL HAZARDS: ELECTROMAGNETIC RADIATION. Ferris, Benjamin G. Jr. (Harvard School of Public Health, Boston). New Engl. J. Med., 275: 1100-5(Nov. 17, 1966).

Biological effects of microwaves, radio waves, infrared, uv, and ionizing radiations are reviewed as a basis for a discussion of hazards of these radiations. Selected effects of uv are described. The shorter uv wavelengths are important as a hazard when germicidal lamps are used or when other man-made sources may be operating. The germicidal range is that at which the nucleoproteins have a high absorption, and this may account for the germicidal effect. The uv in sunlight or from artificial sources is not entirely safe. As with ionizing radiation, biologic manifestations do not appear until after exposure. Therefore, a person can receive an excessive amount before he is aware of the extent of the exposure. If the exposure is sufficiently great there may be marked systemic effects such as fever, nausea, and malaise. Apparently the aging effect of the skin bears a high correlation to the accumulated exposure to uv. In the areas with greatest exposure premalignant or malignant changes are also most likely to develop. Some persons are more sensitive because of the characteristics of their skin or coloration. (BBB)

14740 THEORY OF RADIATION INJURY AND RECOVERY IN SELF-RENEWING CELL POPULATIONS. Sacher, G. A.; Trucco, E. (Argonne National Lab., Ill.). Radiat. Res., 29: 236-56(Oct. 1966).

Models of mammalian radiation lethality and recovery are developed, based on known or assumed properties of self-renewing tissue cell populations. The models incorporate the fact that unconstrained population growth proceeds at a rate proportional to the cell number. Growth within the organism is constrained in various ways so that the several cell populations attain characteristic stationary sizes. The rate of growth is therefore a product of two terms, one of which is a monotone function of attained population size and the other a monotone function of the discrepancy between attained size and limiting size. In the simplest one-compartment case this leads to the classic Pearl-Verhulst logistic equation for population growth or recovery. In the past, mammalian recovery processes were usually modeled as first-order reactions. However, several recent experiments on the effects of split or fractionated exposures have yielded the result that the amount of recovery per day, measured in rads, is constant. This would seem to imply a zero-order recovery process, and such models have in fact been proposed, but they are not very plausible from the point of view of cellular dynamics. It is shown that the logistic model, which has its basis in cell population kinetics, also yields a linear dose-time relation. The model is applied to data on survival after split doses, multiple fractionation, and protracted continuous exposure. (auth)

14741 RADIATION SENSITIVITY OF NORMAL AND POLYOMA-TRANSFORMED RAT EMBRYO CELLS. Williams, J. F.; Till, J. E. (Univ. of Toronto. Ontario Cancer Inst., Toronto). Radiat. Res., 29: 282-94(Oct. 1966).

Radiation survival curves have been obtained for freshly isolated normal rat embryo cells, and for transformed cell lines derived from polyoma-infected cultures and tested for their response to cesium-137 irradiation after short (less than 7 weeks) or long (at least 35 weeks) periods of cultivation in vitro. It was found that newly transformed cells and transformed cell lines which had been cultivated in vitro for less than 7 weeks yielded survival curves characterized by D_0 values which did not differ significantly from D_0 value obtained for normal, noninfected cells. In contrast to this, the survival curves obtained for cells which had been cultivated in vitro for more than 35 weeks yielded results which indicated that the radiosensitivities of at least some of these cell lines, as measured by their D_0 values, were significantly different from each other, and significantly less than the radiosensitivity of normal cells. The survival curves for cells irradiated in vitro and assayed in vitro yielded D_0 values which were similar to those obtained for the same cells irradiated in vitro but assayed in vivo. A comparison of the D_0 values obtained for different lines of transformed cells with other properties of the cells, including efficiency of formation of colonies in vitro and in vivo, growth rate, and ploidy, yielded no consistent correlations, with the possible exception of the efficiency of formation of lung colonies in vivo. (auth)

14742 GROWTH IN THE CHICKEN AFTER HIGH-RATE AND LOW-RATE ^{60}Co GAMMA IRRADIATION. Tyler, Sylvanus A.; Stearner, S. Phyllis (Argonne National Lab., Ill.). Radiat. Res., 29: 257-66(Oct. 1966).

The relative influence of dose and period of exposure on the growth of chicks that survived more than 30 days after single doses of ^{60}Co γ-rays has been described statistically. Chicks, 3 to 4 days of age, were exposed to doses delivered in a few minutes or protracted over 24 hours. When growth to 170 days is fitted to the Gompertz function, the radiation effect can be quantitatively described by a linear relation between weight (arbitrarily chosen at 45 days) and dose. The rates of decrease in weight with dose are approximately the same in the high-rate and low-rate groups, but a loss in dose effectiveness equivalent to approximately 400 R results with protractions of 24 hours. Between 170 and 800 days of age there is a slow but constant increase in weight which is approximately linear. This increase is eliminated by exposure to doses in the acute lethal range. (auth)

14743 RADIATION-INDUCED MITOTIC DELAY IN SEA URCHIN EGGS TREATED WITH PUROMYCIN AND ACTINOMYCIN D. Rustad, Ronald C.; Burchill, Brower R. (Western Reserve Univ., Cleveland. Marine Biological Lab., Woods Hole, Mass.). Radiat. Res., 29: 203-10(Oct. 1966). (COO-78-133).

The mitotic delay arising from exposure to radiation and inhibitors of RNA and protein synthesis was measured in sea urchin eggs. Eggs that had been inseminated with normal or γ-irradiated sperm were exposed to puromycin at various intervals after fertilization. The irradiation of the sperm extended the period of sensitivity to puromycin-induced mitotic delay. This experiment suggests that an inhibition of protein synthesis is involved in radiation-induced mitotic delay. Fertilized sea urchin eggs were incubated with puromycin for approximately 30 minutes and washed. Mitotic delay resulted. This puromycin treatment extended the γ-ray-sensitive portion of the mitotic cycle by as much as 20 minutes. This experiment suggests that protein synthesis must occur before the cells can pass through the radiation-sensitive portion of the mitotic cycle. Actinomycin D did not increase the amount of delay found after irradiation of either sperm or eggs. This experiment indicates that the messenger RNA required for the essential radiation-sensitive protein synthesis is present in the unfertilized egg. (auth)

14744 RADIATION AND WOUND HEALING: INFLUENCE OF DIETARY METHIONINE AND ZINC ON ^{65}Zn DISTRIBUTION AND EXCRETION IN THE RAT. Kinnamon, Kenneth E. (Fitzsimons General Hospital, Denver). Radiat. Res., 29: 184-93 (Oct. 1966).

The effects of 800 rads of total-body x irradiation on distribution and excretion of intraperitoneally injected $^{65}ZnCl_2$ in rats fed diets containing: (1) methionine at 20 mg/gm, (2) zinc at 0.133 mg/gm, (3) methionine at 20 mg/gm + zinc at 0.133 mg/gm, or (4) a basal (control) diet have been studied. Alterations in zinc metabolism have been observed. Radiozinc retention in regenerating wound tissue of irradiated rats of the methionine + zinc group was significantly elevated, but no alterations in the rate of wound healing, as determined by collagen formation, were seen. Evidence is presented which suggests initial impairment of zinc excretory function by irradiation followed by recovery or partial recovery in all groups, but to a lesser degree in the kidneys of rats fed high-methionine diets. (auth)

14745 MICROINCISION OF SICKLED ERYTHROCYTES BY A LASER BEAM. Jensen, Wallace N. (Univ. of Pittsburgh); Bromberg, Philip A.; Bessis, Marcel C. Science, 155: 704-7 (Feb. 10, 1967).

Sickled cells were observed cinematographically after microincision by a ruby-laser beam. Distortion and charring invariably occurred at the site of injury, and with small injuries there was no further cell change. With larger injuries, variably rapid retraction of spicules occurred accompanied by sphering of the cell. In some cases, progressive loss of hemoglobin accompanied and followed the changes in shape; in others the sphered cell still contained hemoglobin. Regardless of the mechanisms involved in these changes in vitro, the observations may be applicable to destruction of sickled cells in vivo. It is suggested that the cells are subject to avulsion of rigid cellular processes as a result of mechanical injury incurred in normal circulation. Such injured cells may undergo either immediate hemolysis or transformation into spherocytes that are subject to erythophagocytosis. (auth)

14746 VARIATIONS IN THE SPECTRUM OF ANOMALIES FOLLOWING X RADIATION OF THE EMBRYOS OF BOMBYX MORI AS A FUNCTION OF HIBERNATION. Coulon, Madeleine. (Faculte de Sciences, Lyon). Compt. Rend., Ser. D, 263: 1153-5 (Oct. 17, 1966). (In French).

The effects of cold temperature on embryos are similar to the effects of radiation in regard to the production of anomalies. Embryos were x irradiated with doses of 1,000 to 5,000 R and incubated under normal conditions. Another series was subjected to hibernation temperature. One group of these constituted the controls and another group was irradiated at 5,000 R. Observations were made after 145, 278, and 343 days. Certain anomalies appeared in the same frequency following hibernation as well as following irradiation. The spectrum of anomalies obtained among the controls after 343 days of hibernation was not significantly different from that obtained under the same conditions among the irradiated. (H.L.W.)

14747 VISCERAL FIBROUS DYSPLASIAS IN THE ANTILLES POPULATION. Le Maistre; Negre. J. Med. Bordeaux Sud-Ouest, 142: 1021-3(June 1965). (In French).

Certain racial differences in the response of tissues injured by ionizing radiations are reported, with reference to observations seen in natives of Martinique who underwent radiotherapy. These natives exhibited a unique cutaneous as well as generalized fibrous tissue response to radiation that has not been observed in Caucasians. The pigmented skin of these natives shows keloid formation and internal structures show excessive fibrosis after radiotherapy. Often this makes differential diagnosis, between cancer recurrence and benign hyperplasia of irradiated tissue, difficult. In irradiated patients with uterine cancer, the late complications often take the form of fibrous adhesions between the bladder, rectum, and vagina. In the Antilles population these reactions, seen to some extent in Caucasians, are seen earlier and are more severe. Heavy parametrial bands of fibrous tissue may develop and may mimic the symptoms of cancer. This appears to be a qualitatively specific racial response to the injurious effects of radiation. (BBB)

14748 HISTAMINE AND X RAYS: EXPERIMENTAL RESEARCH ON THE RAT WITH A HISTAMINE LIBERATOR (48/80) WITH AN ANTIHISTAMINE (PROMETHAZINE) AND WITH SIMULTANEOUS ASSOCIATION OF BOTH. Romani, S.; Zacchi, C. (Univ., Padua). Quad. Radiol., 30: 567-76(Jan.-June 1965). (In Italian).

Experiments were conducted in Wistar rats subjected to 600-R, whole-body doses of x rays. The rats were injected intraperitoneally with 0.1 mg of the histamine liberator Compound 48/80 before irradiation. Other rats were injected with 1 mg of the antihistamine agent promethazine before irradiation, and another group of animals was given similar doses of both drugs. Three of the 20 animals in the irradiated control group died in the first 10 days whereas no rats in the other 3 (drug-treated) groups died in this period. In the next 10-day period 4 of the controls died compared with only 1 each in the other 3 groups. The 30-day survival rate in the first group was 60% as contrasted to 95% in each of the other 3 groups. The results show that both of these compounds have radioprotective activity when given singly or in combination. (BBB)

14749 TRANSPORT FUNCTION IN THE ENDOPLASMIC RETICULUM OF SUBLETHALLY IRRADIATED CHICKEN MYOBLASTS. Schaefer, Dieter (Univ., Bonn). Z. Zellforsch. Mikroskop. Anat., 71: 562-73(1966). (In German).

After sublethal irradiation of cultured chicken myoblasts with 1200 R of x radiation, vacuoles were observed in the cytoplasm

by means of phase contrast microscopy. They form large vesicles following migration and fusion within the cytoplasm. They are transported to the surface of the cell and later excreted. The radioinduced vacuoles are found only in the perinuclear space and appear in channels of the endoplasmatic reticulum as vesicular enlargements that have no contrast properties. The bright tracks within the cytoplasm can be observed by phase contrast as portions of the endoplasmic reticulum where vacuolar movements are readily detected, suggesting a transport function of the endoplasmic reticulum of the irradiated myoblasts. Using the space within the endoplasmic reticulum the vacuoles migrate to the cell periphery where they become attached to the cell membrane. The contents of the vacuoles leave the endoplasmic reticulum a short time later. (BBB)

14750 QUANTITATIVE CHANGES OF THE FREE -SH GROUPS IN THE BLOOD PLASMA AND URINE AS A RESULT OF RADIOTHERAPY. Fabian, N.; Pora, E. A.; Chiricuta, I.; Simu, G.; David, E. (Oncological Inst., Cluj. Babes-Bolyai Univ., Cluj). Stud. Cercet. Fiziol., 11: 241-5(1966). (In Rumanian).

The thiolic group of thioenzymes is attacked by the free radicals created by ionizing radiations. The high yield of the oxidation of the -SH group, causing the inactivation of the thioenzymes is due to the high affinity to free radicals. This problem was studied by determining the free -SH group concentration in the blood plasma and urine of patients suffering from various malignant tumors before and after the administration of x ray therapy; an amperometric-argentometric method was used for the determination. The results revealed that the concentration of the -SH groups in blood plasma with respect to that in the reference individuals was reduced by 3.07% in the case of patients suffering from skin cancer and by 7.80% in the case of other malignancies. This decrease was even more pronounced after completion of the radiotherapy: one hour after the first dose, the -SH concentration decreased by 9% in patients with skin cancer and by 17.75% in patients suffering from mammary, cervical, and gastric cancer; at the end of the series of treatments, this concentration decreased by 20 and 27% respectively. No statistically meaningful changes were observed in the urine of the patients, as compared with individuals in the control group. (TTT)

14751 CHROMOSOME REARRANGEMENTS INDUCED BY X RAYS IN AKR/Tr MICE. Leonard, A.; Deknudt, Gh. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Experientia, 22: 715-16(Nov. 15, 1966). (In French).

A spontaneous translocated strain of mice (AKR/Tr.) with 36 acrocentric and 2 metacentric chromosomes received 400 R of whole-body x irradiation. Cytological examination of dividing primary spermatocytes at the diakinesis-first metaphase stage of meiosis showed 6% of cells with chromosomal rearrangements. (auth)

14752 OBSERVATIONS ON A STRAIN OF RATS WITH CATARACTS INDUCED BY X RAYS. Leonard, A.; Maisin, J. R.; Deknudt, Gh. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Experientia, 22: 744(Nov. 15, 1966). (In French).

The hereditary cataract induced by x irradiation of a female rat during infancy appears to be different from the spontaneous hereditary cataracts previously described in the rat. No significant difference was found between the weight of mutants and controls. This phenotype seems to be related to some alterations in the metabolism of the carbohydrates. (auth)

14753 ISONIACID METABOLISM IN THE COURSE OF ACUTE RADIATION SYNDROME IN RATS. PART I. BLOOD AND PLASMA LEVELS AFTER INTRAVENOUS AND ORAL ISONIACID ADMINISTRATION. Simane, Z. (Karls-Univ., Hradec Kralove, Czech. Tuberkulose-Forschungsinstitut, Prague). Radiobiol. Radiotherap., 7: 481-5(1966). (In German).

The blood and plasma concentration of Isoniazid was followed in normal and x irradiated rats three and six days after an application of 600 R following intravenous and peroral administration of 50 mg/kg. Only unimportant and partly statistically non-significant changes of blood concentration caused by irradiation were found after intravenous administration. Following peroral administration three days after irradiation the blood level was significantly lower than in the controls. That is obviously caused by intestinal resorption during the gastrointestinal stage of the radiation syndrome. On the other hand, six days after irradiation a higher blood level was found than in the controls. This may be due to a radiation-induced partial interference with the reducing systems. The distribution of Isoniacid between blood plasma and erythrocytes will be influenced by irradiation so that plasma concentration decreases whereas blood concentration does not change. This phenomenon probably depends on the damage of erythrocyte wall. (auth)

14754 CYTOLOGICAL STUDIES ON BLOOD AND BONE MARROW CELLS WITH THE PHASE CONTRAST MICROSCOPE. REPORT 2. PHASE CONTRAST MICROSCOPIC STUDY ON THE INFLUENCE OF INTERNAL RADIATION WITH ^{32}P UPON THE BLOOD AND BONE MARROW CELLS OF MICE. Miyazaki, Shigetake (Kyoto Univ.). Naika Hokan, 8: 616-27(July 20, 1961). (In Japanese).

Blood and bone marrow cells and the lymph nodes, as well as the migration velocity of neutrophil leucocytes, were studied with phase contrast microscopy at regular intervals following internal radiation with ^{32}P (2.5, 5.0, or 1.0 $\mu C/g$ body weight), to follow early changes after β irradiation. Normal blood and bone marrow cells of mice were essentially the same in their cytological characteristics as those of human beings, but the cells were smaller and the maturity of granulocytes was less distinct in the mice. The mean migration velocity was 27.93 μ/m at 37°C. Injurious effects of ^{32}P on the cells were observed with lapse of time. When 2.5 or 5.0 $\mu C/g$ was administered, there was max cellular damage, and in the case of 10 $\mu C/g$ there was a high degree of cellular destruction at 3 to 7 days and all the mice died by the 14th day. Changes of migration velocity of neutrophil leucocytes were in parallel with the cellular damage. After 2.5 and 5.0 $\mu C/g$ ^{32}P administration, appearance of large immature and mature granulocytes was observed around the 15th day. (BBB)

14755 FEMUR FRACTURES RESULTING FROM THERAPEUTIC IRRADIATION FOR GYNECOLOGICAL TUMORS (PREVENTIVE MEASURES). Landrgot, B.; Sauer, J. (State Hospital Faculty, Pilsen, Czech.). Zentralb. Gynaekol., 87: 835-41(1965). (In German).

The authors report on 32 women who were treated for spontaneous unilateral or bilateral fracture of the femur subsequent to irradiation of the pelvis during treatment of genital tumors. The average age of the patients was 62.5 yr. The average time interval between irradiation and appearance of the fractures was 2.5 yr. The interval between the beginning of the subjective symptoms of fracture and its recognition amounted to an average of 4.7 months, ranging from only 5 weeks to as long as 1 yr. The incidence of spontaneous fracture in irradiated patients was between 2.5 to 3%. The irradiation received consisted of crossfire fields with centering in the pelvis at an angle of 35°. On the average the total skin dose in a single field amounted to 3000 to 3200 R, the depth dose in a perpendicular direction at the parametrium averaged from 2400 to 2600 R, and with crossed fields it was 3400 to 4000 R. The daily dose per field was 250 R with irradiation from two fields (either two frontal or two caudal). Usually the irradiation series was completed within 5 weeks. Ra implants were also used to administer 7000 R. Other irradiations were also performed using other fields and giving 100 to 200 R daily until 3000 R/field had been administered. X-ray studies of the fracture area during the early phase showed increased density at the edge of the femur head and osteodystrophic foci at the upper border that resembled metastatic processes. (BBB)

14756 EFFECTS OF PRENATAL GAMMA RADIATION ON TESTICULAR MORPHOLOGY AND FUNCTION IN SWINE. Pace, H. B.; Murphee, R. L.; Hupp, E. W. (Univ. of Tennessee, Oak Ridge). Amer. J. Vet. Res., 22: 406-11(May 1961).

This study was conducted to determine the effects of a single sublethal exposure of gilts in midgestation to ^{60}Co γ radiation on the viability, growth, testis morphology, and semen characteristics in the male offspring. The gilts were exposed to 400 R on the 54th to 64th day of pregnancy. Testes weights of irradiated males were ~30% less than those of comparable age control males. There was no difference in the average sperm concentration; however, the irradiated boars produced 22% less semen and 35% less sperm per ejaculum than the control boars. No difference in initial fructose concentration in the semen or oxygen utilization during a 75-min incubation period was observed. An increased amount of intertubular tissue was seen in the testes of some of the irradiated boars. However, this increase may be only relative. The reduction in total sperm production in the irradiated boars was roughly proportional to the reduction in percentage of active seminiferous tubules. The reduction in semen volume was probably due to the reduction in size of the accessory glands in the irradiated boars; (a reduction of 17 and 26% in mature prostate and seminal vesicle weights, respectively, was noted in rats irradiated on the 17th day of gestation). (BBB)

14757 CURRENT PROBLEMS OF LIGHT BIOLOGY AND THERAPY IN DERMATOLOGY. Wiskemann, A. (Univ., Hamburg). Hautarzt, 16: 337-40(Aug. 1965).

The author reviews and discusses the results of previous studies of production of uv erythema, light pigmentation, and

use of light therapy. The uv ranges studied included 100 to 280 nm, 280 to 315 nm, and 315–380 nm. Factors studied included differential skin sensitivity to uv light at these wavelengths in persons normally sensitive and exceptionally sensitive. The composition, depth, and thickness of various skin layers were taken into account. The mechanism of genesis of uv skin erythema was discussed. Biochemical and genetic factors that were considered included DNA, pyrimidine bases, proteins, amino acids, histamine, and amino acid derivatives. Inactivation of enzymes and limitation of uv erythema by nonspecific heat erythema are discussed. The localization and mechanisms of production of light pigmentation are discussed. These include, among others, direct or immediate pigmentation. The role of vascular factors is also reviewed. Treatment of skin diseases, such as psoriasis, pityriasis rosea, acne vulgaris, furunculosis, and seborrheic eczema, by uv light is discussed. Methods, equipment, and results are reviewed briefly. References cited, 72. (BBB)

14758 CHANGES IN PERIODONTIUM OF UPPER INCISOR OF THE RAT FOLLOWING X-RAY IRRADIATION. Bily, B. (Lekarske Fakulty, Brno). Cesk. Stomatol., 65: 250-5(July 1965). (In Czech).

Histological changes in the periodontium of the upper incisors of Wistar rats that were subjected to various local doses of 180-kV x rays were studied. In 105 animals, weighing 150 to 250 g, doses of 200, 600, 1200, 2400, or 4800 R were delivered at a dose rate of 166 R/min. Tissue sections were examined 1 to 77 days later, and morphologic changes in the periodontium were noted, described, and illustrated. Typical changes in enamel, cementum, and apical periodontium were observed at doses of 1200 R and higher. Structural modifications were characterized by hyperemia, injury to vascular endothelial cells, and changes in permeability of the blood vessels. Leakage of plasma proteins into the periodontal tissues occurred, and this was followed by fibrosis and hyalinization. This, in turn, resulted in calcification of the periodontium which impaired eruption of teeth. These changes were most predominant in rats treated with 4800-R x radiation. (BBB)

14759 ACTION OF IONIZING RADIATION ON THE FETUS (POINT OF VIEW OF THE RADIOLOGIST). Lefebvre, J. (Hopital des Enfants-Malades, Paris). Ann. Pediat. Sem. Hop., 37: 2473-6(Aug.–Sept. 1961). (In French).

An evaluation is made of the hazards of irradiation of the human fetus, particularly during diagnostic radiology in pregnancy. The risks are discussed in terms of mutations from gonadal exposure, leukemia and cancer induction, and congenital anomalies. The genetic risk is similar for the fetal and the adult but protection of the fetal gonads is, of course, impossible during radiographic procedures. Various reports relating to in utero leukemogenesis and carcinogenesis following irradiation are discussed; this question remains controversial. The fetal anomalies that can be produced include anencephalia, microcephalia, encephalocele, hydrocephalus, cerebral atrophy, microophthalmia, cataract, nystagmus, chorioretinitis, strabismus, spina bifida, palatine fissure, and hypophalangism. Mongolism is also a possible sequelae of in utero irradiation. The relation of the stage of organogenesis to the induction of these changes is discussed. Measures which should be observed by radiologists in obstetrical cases to avoid the possibility of such fetal injury are presented. (BBB)

14760 ON THE PATHOGENESIS OF CONGENITAL STAPHYLOMA OF THE CORNEA. HISTOLOGICAL FINDINGS IN MAN AND ANIMAL. Badtke, G. (Univ. Halle, Ger.). Klin. Monatsbl. Augenheilk., 146: 496-516(May 1965). (In German).

Macroscopic findings in the cornea of the offspring of a female guinea pig that had been x irradiated abdominally during the eighth day of pregnancy with a single dose of 250 R consisted of microphthalmia. Microscopically, there was impaired separation of the lens vesicle, with a central corneal defect. The empty lens capsule sac collapsed into the conjunctival sac, indicating previous aphakia. There was also progressive cicatrization in the margins of the corneal foramen which originated from the vessels of the prolapsed iris and from the pupillary membrane. A corneal leucoma or formation of Peter's defect was indicated. Compared with congenital corneal staphyloma and parenchymal opacities observed in a human infant, and with previous findings, the conclusion was reached that congenital central opacities constitute a teratological series. The formal development, factors affecting developmental mechanics, the causal genesis, and the teratogenic determinative period are discussed. Irradiation during the early developmental period is a relatively infrequent cause of these malformations. From a causal-genetic point of view most cases result from multifactorial processes, but genic etiology also plays a role. In rabbits and mice the teratogenic period probably is up to the eighth day of development, and in humans it may extend into the third week of embryonal development. (BBB)

14761 SEVERE LIFE-THREATENING INJURIES FROM RADIUM FORGOTTEN IN THE HOME. Born, Willi (Univ., Freiburg i. B.). Deut. Aerztebl.-Aerztl. Mitt., 63: 857-60 (Mar. 26, 1966). (In German).

A series of carcinoma cases, apparently due to Ra compresses sold directly to the public for treatment of various types of diseases, has been reported. These items consisted of shoe inserts, pillows, bandages, etc. Their sale was stopped by regulations issued in 1960, but many of these items are now probably widespread and uncontrolled in their use or carelessly forgotten. A number of tumors with tendencies to metastasize have resulted from their use. It has not been possible to make the companies that distributed these radioactive items comply with control measures. Some contain 0.2 mg or more of Ra. Dose rates are difficult to estimate, but values of 1600 mrep/hr and 1500 mrad/hr have been reported. Additional information and notification of this hazard should be published. (BBB)

14762 BIOLOGICAL MECHANISM OF AGING. Curtis, Howard J. Springfield, C C Thomas, 1966. 133p.

Various theories of the aging process are reviewed, including those relating to radiation-accelerated aging. Animals subjected to ionizing radiations age more rapidly, and have a shorter life expectancy than controls. At autopsy it is found that, in general, the same diseases that are responsible for the death of normal animals are also responsible for the death of irradiated animals, but they contract the diseases sooner. Thus, it appears that radiation accelerates the development of all forms of degenerative diseases. Objections to this phenomenon as a true acceleration of aging are considered. Evidence primarily from studies on chromosome aberrations in mice and comparisons between natural and radiation-induced aging have shown a close correlation between the production of chromosome aberrations (mutations) and aging. The studies give support to the somatic mutation theory of aging, but show that it must be modified in at least two important regards. First, there is a long time lag between mutation production and its ultimate effect on aging; so only the mutations produced while the animal is relatively young are effective in shortening the life span. Next, during this time lag the cells are existing on previously synthesized components (RNA and proteins), so to some extent the duration of life will depend on the utilization of these components (rate of living). Also, mutations may be very important in aging in some forms (mammals), but are probably of minor importance in others (plants). (BBB)

Radiation Effects on Plants

Refer also to abstracts 14599, 14604, and 14690.

14763 UV STIGMATA ON BLOSSOMS. Kugler, H. Ber. Deut. Botan. Ges., 79: 57-70(May 1966). (In German).

In radially developing disk, cone, bell, and pedunculate flowers only radial patterns, streaks, and spots appear in the pigmentation induced by exposure to uv light. Radial patterns also appear in star figures if there are combinations of very reflective sepals and petals, as in Acer platanoides. Purely uv stigmata occur in 26% of the flowers mentioned, and 30% of these are visible. This is very pronounced in the pedunculate flowers. Aggregated flowers indicate their radial structure by the almost equally frequent appearance of uv-free stigmata. The central blossoms do not reflect the uv light strongly, but the peripheral ones do. In tubiflora with ligulate marginal flowers the petals reflect uv either apically or over the entire area. UV-free markings are developed dorsiventrally in the dorsiventral labiate and papilionaceous flowers. In the labiate flowers these appear mostly in the form of uv-free spots on the labrium, which is the slighting point of insects. Pure uv stigmata are relatively rare, occurring in only 9%, of which 61% are visible. Pigments apparently with spectra in the visible range are used for this color formation. In papilionaceous flowers the uv-free stigma appears at first as a basal spot on the flag, from which veins irradiate outward. It may spread to the lobe and carina, but usually these are uv free in their entire aspect. There are three groups of visible uv stigmata, classified in terms of their frequency. For the disk, cone, and bell flowers the frequency is about 50%, pedunculate, aggregated, and labiate flowers show a frequency of about 70%, and the papilionaceous flowers have the highest, about 88%. There seems to be a relation between flower shape and frequency of stigmata, which increases with complexity of the blossom production. Contrast colorations do not play any role in brush flowers. They are widespread in trap flowers, but a pure uv

stigma was found only in Ceropegia fusca. The proportion of uv patterns in ornithogamia is very small. (BBB)

14764 IONIZING RADIATIONS: BIOCHEMICAL, PHYSIOLOGICAL, AND MORPHOLOGICAL ASPECTS OF THEIR EFFECTS ON PLANTS. Gunckel, J. E.; Sparrow, A. H. (Rutgers Univ., New Brunswick, N. J.). pp 556-611 of Encyclopedia of Plant Physiology. Vol. 16. Ruhland, W. (ed.). Berlin, Springer-Verlag, 1961.

This review, with 315 references, is mainly concerned with the nongenetic effects of ionizing radiations on plants. The nature of the morphological or developmental effects are described and are interpreted as the consequence of the biochemical or physiological disturbances induced by the irradiation. Radiation biochemistry aspects of irradiation responses are discussed. The complex chain of events, from the initial physical event of energy transfer to the eventual detectable biological effect(s) at a gross level, is outlined with examples. Effects on enzymes in the cell may be the primary nongenetic biochemical lesion induced by ionizing radiation. However, secondary or tertiary events usually follow, and these are related to vital physiological processes and are mediated by many simple or complex variables. Radiation-induced changes are discussed with reference to: auxin synthesis, DNA synthesis and mitotic rate, amino acid and protein syntheses, respiration, enzyme activity, growth inhibition or stimulation, photosynthesis and pigmentation, the flowering response, and other miscellaneous effects. The synthesis of auxin seems to be the most sensitive nongenetic effect so far studied in plants. This suggests that the resultant altered concentrations of auxin would be a logical cause of many secondary effects. Cytological, genetic, morphological, and physiological changes in cells result in abnormal or aberrant growth of meristems, roots, stems, leaves, and flowers, including varying degrees of growth inhibition and occasional growth stimulation. Morphogenetic effects on higher plants are summarized in tabular form, and possible physiological explanations are presented. Factors which influence the tolerance or radiosensitivity of plants are also given in a table, together with bibliographical listings. (BBB)

14765 PHOTOOXYDATIVE BLEACHING OF CHLOROPHYLL PIGMENTS IN VIVO CAUSED BY CHROMATIC RADIATION. Zurzycki, J. (Jagiellonian Univ., Krakow). Acta Soc. Bot. Pol., 33: 121-32(1964).

Decomposition of chlorophyll in the cells of the moss Mnium undulatum, as caused by strong intensities of uv and visible radiation, was investigated. Changes in the amount of chlorophyll was measured by the method of Shibata using opal glass. Photooxidative bleaching was induced by all ranges of visible radiation the action being proportional to absorption by the photosynthetic pigments (the most active one being in the blue range, red less, and green weakest). Infrared light did not cause any pigment decomposition effect. Near-uv radiation (310 to 405 mμ) applied at an intensity up to 8.8×10^5 erg/cm^2 sec caused no measurable decomposition of chlorophyll in the course of 6-hr exposure. Higher intensities of near-uv were capable of causing bleaching. Far-uv (250 to 300 mμ) did not cause any decomposition of chlorophyll. Cytological tests showed that higher intensity far-uv irradiation (1.15×10^5 erg/cm^2 sec) caused, after 1.5 to 2 hr, the death of all cells. Nevertheless, in the course of a further 4-hr exposure no transluctance changes were observed. Photooxidative action was evident only with radiation at an intensity exceeding a definite limit (different for each spectral range). In the course of decomposition, an inductive phase and a bleaching phase could be differentiated. In all spectral ranges in which chlorophyll decomposition was seen, the kinetics of decomposition was similar. These experimental results and data from the literature concerning the spectral action of radiation on decomposition of photosynthetic pigments based on the method of differential filters were discussed. (BBB)

14766 OCCURRENCE OF 2C(G_1) AND 4C(G_2) NUCLEI IN THE RADICLE MERISTEMS OF DRY SEEDS IN TRITICUM DURUM DESF. ITS IMPLICATIONS IN STUDIES ON CHROMOSOME BREAKAGE AND ON DEVELOPMENTAL PROCESSES. Avanzi, Silvana; Brunori, A.; D'Amato, F.; Ronchi, Vittoria Nuti; Mugnoza, G. T. Scarascia (Comitato Nazionale per l'Energia Nucleare, Rome). Caryologia, 16: 553-8(1963).

In experiments on the relative radiation sensitivity of 2 varieties of wheat Triticum durum (Aziziah and Cappelli) in which dry seeds (caryopses) were x irradiated with various doses, it was found that some aberrant anaphases scored in the first mitotic cycle of the seedling roots showed chromatid type aberrations. This suggested that several nuclei in the G_2 phase of the mitotic cycle may be present in the embryo radicle of seeds in the dry state. Analyses aiming at establishing the relations between chromosome breakage and DNA amount in radicle meristem cells in dry wheat seeds were made. Dry seeds of the Cappelli variety were irradiated with 3500 to 15,000 R. The results showed that, in the radicle meristem in dry wheat seeds interphase nuclei with both 2C and 4C DNA amounts are present. Since wheat embryos have well developed root apices, some degree of cell differentiation seems to occur in them. It is, therefore, possible that some 4C nuclei represent nuclei which underwent DNA synthesis in connection with differentiation and, consequently, will not any further enter mitosis in the seedling root. These may include some root cap cells, a few provascular cells, as well as cells at the base of the meristem. Labeling (^{3}H-thymidine) experiments, however, showed that several meristem nuclei enter the first mitotic cycle in the germinating seeds without DNA synthesis, thus demonstrating that they were in the G_2 period in the dry seed state already. These can remain in the G_2 period for comparatively long durations and enter mitosis directly from G_2. The labeling experiments in irradiated seeds showed that anaphases with chromosome aberrations were all labeled, demonstrating that the chromosomes had been hit by radiation in the upsplit condition (G_1). Of the anaphases showing chromatid type aberrations, some were labeled and some were not, the latter deriving from nuclei which were irradiated in the split condition (G_2). Labeled anaphases with chromatid aberrations presumably derive from nuclei with DNA intermediate values (i.e., stopped during DNA synthesis by the maturation process), which were able to resume synthesis towards G_2 and mitosis in the germinating seed. (BBB)

14767 ROSE CULTURE USING X IRRADIATION. Streitberg, Hanna (Deutsche Akademie der Landwirtschaftswissenochaften, Berlin). Arch. Gartenbau, 14: 81-8(1966). (In German).

A total of 2650 rose buds including 42 different species were irradiated with 200 kV x radiation. The roses exhibited roughly 3 levels of susceptibility to irradiation. The most susceptible included 14 species, the medially susceptible included 19 species, and 9 species were relatively resistant to irradiation. The optimal dose was taken to be one that was 50% lethal. For the most susceptible group the optimal dose was from 1500 to 6000 R. For the middle group the optimal dose was from 1000 to 3000 R, and for the third group the dose was from 500 to 1000 R. The doses were selected to avoid growth depression. The percent of mutational variants obtained for each species was determined and correlated with the percent of variants obtained at several levels of irradiation. For 500, 1500, 2450, 4000, 6000, and 8000 R the percent of variants obtained was 12.5, 35.0, 25.0, 17.5, 5.0 and 5.0%, respectively. The types of variants produced included vegetative, bloom form, reduction in aroma, and color change. Many of the color changes ranged widely. (BBB)

14768 MORPHOLOGICAL HETEROGENEITY IN ANDROPOGON GROWING ON AREAS OF HIGH AND LOW NATURAL BACKGROUND RADIOACTIVITY. Skeen, James N.; Plummer, G. L. (Univ. of Georgia, Athens). Bull. Ga. Acad. Sci., 24: 100-16 (Sept. 1966).

Attempts were made to determine whether some herbaceous perennial species common to areas of both high and low natural background and radioactivity exhibit any gross morphological differences, and, if so, whether these differences might be accepted as indicator criteria of the prevailing natural-background conditions. The number of culms per cm basal dia was considered to be a suitable index of morphological variation. The naturally occurring species Andropogon (broomsedge), perennial grasses common 6 to 10 years after abandonment of crop fields and bare road cuts, was studied in terrains varying in background activity from 300 to 2100 cps. Although differences in number of culms per unit basal diameter occurred in conjunction with differing levels of background radiation, a correlation could not be demonstrated between the number of culms and the background radiation level. That is, a cause and effect relation was not detected. Furthermore, since the direction of the differences was reversed in successive growing seasons, such differences could not be accepted as valid indicator criteria of the prevailing natural radioactivity. Although both the average number of culms per cm basal diameter and fallout radionuclide levels during 1964 were greater than the corresponding values during 1965, these relations were probably coincidental, even though very small amounts of ionizing radiation may stimulate certain kinds of plant growth. Therefore, variations in Andropogon morphology and biomass productivity, particularly within populations of the diploid A. virginicus, were believed to be influenced more by normal genetic and physiologic mechanisms than by either natural radioactivity or by such levels of fallout radioactivity as have existed for the past 4 to 5 yr, the probable age of the populations investigated. (BBB)

14769 RELATIONSHIP BETWEEN RECOVERY FROM SUBLETHAL DAMAGE BY DOSE FRACTIONATION AND THE RESTORATION OF VIABILITY AFTER DELAYED PLATING IN DIPLOID SACCHAROMYCES CEREVISIAE. Bacchetti, Silvia;

Cassandro, Marzio; Elli, Raffaella; Falchetti, Roberto; Mauro, Francesco (Univ. of Rome). Radiat. Res., 29: 295-315(Oct. 1966).

Experiments have been performed to study in the same cell population of diploid Saccharomyces cerevisiae recovery from sublethal damage by x-ray dose fractionation and recovery from lethal damage by delayed plating. The purpose of this investigation was to clarify the time course of the events of the two processes and to examine any interaction between them. The results indicate that the kinetics of the two processes show rather marked differences and that the two processes themselves are independent; that is, recovery from sublethal damage has no effect on the ability of a cell to recover from subsequently induced lethal damage. (auth)

14770 PATTERNS AND RATES OF RECOVERY IN SYNCHRONOUS POPULATIONS OF ALGAL CELLS EXPOSED TO GAMMA RADIATION. Davies, D. Roy (Wantage Research Lab., Eng.). Radiat. Res., 29: 222-35(Oct. 1966).

The patterns and rates of recovery in synchronous populations of algae exposed to γ-radiation at different stages of the cell cycle were determined by obtaining full survival curves after dose fractionation treatment. The D_0 values of irradiated cells were similar to those of unirradiated cells at the same stage of development. The rate of recovery of the shoulder was shown to vary slightly at different times in the cycle and furthermore was more rapid immediately after irradiation than at later times. (auth)

14771 STUDY OF RADIATION RESTORATION OF ARTICHOKE RHIZOME TISSUES INDUCED BY KINETIN, GIBBERELLIC ACID, AND RNA OF YEAST. Jonard, Robert. Compt. Rend., Ser. D, 263: 1084-5(Oct. 17, 1966). (In French).

Rhizomes of artichokes were x irradiated with doses of 1,000 to 3,000 R. Samples of tissues were placed in a medium containing indole-acetic acid. Kinetin was added to one part of this medium; yeast RNA was added to another part; and gibberellic acid was added to another part. Results are tabulated. The ability of the irradiated tissues to grow in vitro was partially restored by kinetin and yeast RNA. However, the gibberellic acid did not induce a restorative effect. (H.L.W.)

Radiation Effects on Microorganisms

Refer also to abstract 14609.

14772 (BNWL-280, pp 8-10) EFFECT OF BILE AND RADIATION ON INTESTINAL FLORA. Mahony, T. D.; Sullivan, M. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Coliform bacterial counts are increased in the small intestine of rats by either bile duct cannulation or exposure to x rays. The influence of these factors on the bacterial flora appear to be additive. (auth)

14773 EFFECT OF ULTRAVIOLET LIGHT ON ERYSIPHE GRAMINIS f. sp. HORDEI. Moseman, J. G.; Greeley, L. W. (Dept. of Agriculture, Beltsville, Md.). Phytopathology, 56: 1357-60(Dec. 1966).

Ultraviolet radiation is known to affect the germination, growth, and development of many fungi. The effect of uv irradiation on the germination, infectivity, and development of the obligate pathogen Erysiphe graminis f. sp. hordei was determined. An average of 78% of the conidia shaken from plants grown in a controlled-environment room for 7 days after inoculation germinated on 2% water agar. The reduction of germination required a longer exposure to uv radiation than the reduction of infectivity of the fungus Detached barley leaves were placed on or in benzimidazole and then inoculated to determine the effect of uv radiation on disease development. The effectiveness of uv light in reducing fungal growth and development decreased as the time between exposure and inoculation increased. This suggests that the effect of exposure to uv light is correlated with the establishment of the fungus in host tissue. (BBB)

14774 INVESTIGATIONS ON THE EFFECT OF BETA RAYS ON DERMATOPHYTES. Meinhof, W.; Wiskemann, A. (Univ., Marburg, Ger.). Arch. Klin. Exp. Dermatol., 223: 199-216 (Sept. 1, 1965). (In German).

Trichophyton mentagrophytes cultures were β irradiated with 4.2×10^5 rad from a $^{90}Sr-^{90}Y$ applicator, administered over a period of 22 hr. Out of 29 primary cultures exposed to the irradiation, 14 showed no mutations as compared to the starting culture. Pleomorphic growth was exhibited by 2 of the cultures. In 2 other cultures the granulous nature of the surface was missing after irradiation. These showed sparse, greyish mycelia, with fringed border. Ten cultures exhibited more marked variations from the normal. Four showed formation of red or yellow and red pigmentation, 3 cultures developed verrucous forms of growth, 2 developed ligulate extensions at the rim of the colonies, and 1 culture exhibited very rapid growth, with sparse greyish-yellow mycelia. The amino acid requirements of the cultures were tested. The only amino acids that were not required by the cultures were histidine, tryptophan, and serine. There were definite differences in the sensitivity of the various irradiated cultures to griseofulvin, but there was no definite, clear relation between this or the amino acid requirement and any definite morphological differences observed in the irradiated samples. (BBB)

14775 IMPAIRED COMPLEMENTATION BETWEEN NONALLELIC MUTATIONS IN NEUROSPORA. de Serres, Frederick J. (Oak Ridge National Lab., Tenn.). Nat. Cancer Inst. Monogr., No. 18, 33-52(Dec. 1965).

Radioinduced mutations in the haploid organsim Neurospora are described in the course of development of a new system for the genetic analysis of effects, generally associated with mutations induced in diploid organisms. The system consists of a genetically marked 2-component heterokaryon (referred to as a dikaryon) that permits the recovery and analysis of both intragenic and extragenic mutations at specific loci. Mutations induced in the dikaryon at two closely linked loci (ad-3A and ad-3B) in the ad-3 region with x ray treatment could be grouped as follows: (1) ad-3^R mutation, reparable mutations that increase linearly with radiation dose, and will grow as homokaryons on adenine-supplemented minimal medium; and (2) ad-3^{IR} mutations, irreparable mutations that increase as the square of the x-ray dose and will not grow as homokaryons even on complete medium. Nonallelic complementation between pairwise combinations of ad-3^R and ad-3^{IR} mutations at the ad-3A and ad-3B loci was studied by determining the linear growth rates of forced dikaryons. Such analyses led to the following general conclusions: (a) ad-$3A^R$ + ad-$3B^R$ combinations grow at wild-type growth rate; (b) ad-$3A^{IR}$ + ad-$3B^R$ or ad-$3A^R$ + ad-$3B^{IR}$ combinations may grow at less than wild-type growth rate; and (c) ad-$3A^{IR}$ + ad-$3B^{IR}$ combinations always grow at less than wild-type rate and may grow 10 times more slowly. The reduction in growth rates of dikaryons involving ad-3^{IR} mutations was interpreted as resulting from reduced functional activity of nonallelic loci in the immediately adjacent regions. Such behavior provides presumptive evidence for position effects in the ad-3 region of Neurospora. The extent of genetic damage associated with the inactivation of the ad-3A or ad-3B locus in the ad-3^{IR} mutations can be estimated, and the extent of the functional inactivation of linked wild-type loci in the immediate vicinity of the ad-3 region determined by means of homology tests with genetically marked strains containing linked biochemical or morphological markers. (BBB)

14776 PHOTOREACTIVATION OF ULTRAVIOLET-INDUCED CONJUGATION DELAY IN PARAMECIUM. Ehret, Charles F. (Argonne National Lab., Ill.). pp 287-8 of Progress in Photobiology. Christensen, B. Chr.; Buchmann, B. (eds.). Amsterdam, Elsevier, 1961.

Two criteria of uv damage and repair by photoreactivation were studied in Paramecium bursaria. The first, not involving DNA replication, was that of uv induction and photoreactivation of induction of phase shift of the circadian rhythm for mating capacity. This effect could be correlated with RNA or with nucleotide-coenzyme syntheses which continue rhythmically even in a non-dividing cell population. Far-uv irradiation induced conjugation delay; this was dose-dependent, and at high doses some cells died while still fused. Sensitivity to uv (254 mμ) appeared to increase slightly until late prophase of the first meiotic division, after which it decreased significantly. Conjugation delay, therefore, correlated closely with inhibition of meiosis, and is probably caused by damage to this mechanism. This damage is photoreactivable with a dose reduction of about 40%. The magnitude of photoreactivation was not diminished when reactivating light was applied within 2.5 hr after uv, i.e., up to the time of early prophase. Photorecovery was less when light was applied 4.6 hr after uv treatment, during crescent to late prophase. The action spectrum for the photoreactivation of conjugation delay was measured. There was a single broad peak of spectral efficiency at 420 mμ, with enhancement of the deleterious effects of far uv by wavelengths shorter than 340 mμ. In the induction of half-max effects by either 254 mμ (delay) or 420 mμ (reactivation) the ratio of number incident quanta at 420 mμ per number of incident quanta at 254 mμ was over 50 to 1. The action spectrum is similar to that observed for photoreactivation in several other cells. (BBB)

14777 CHEMILUMINESCENCE ON EXPOSURE OF NORMAL AND IRRADIATED YEAST CELLS TO THE ACTION OF FREE RADICALS. Petrusevich, Yu. M.; Konoplyannikov, A. T. (Lomonosov State Univ., Moscow. Inst. of Medical Radiology, Obninsk, USSR). Biophysics (USSR)(Engl. Transl.), 10: 580-3 (1966).

Translated from Biofizika, 10: 524-6(1965).

The spectrum of luminescence induced in cells of the diploid strain of the yeast, Saccharomyces vini, by exposure to free oxidative radicals was measured. It was concluded that luminescence appears on oxidation of lipids of the yeast membrane by the free radicals diffusing into the solution. The kinetics of luminescence was measured in a dense suspension of yeast cells exposed to doses of 30, 60, and 90 krad γ radiation. The spectrum of luminescence of the irradiated cells did not differ from that of the irradiated ones. (C.H.)

14778 RADIATION-INDUCTION OF THE PROPHAGE OF E. COLI K 12 (λ) UNDER DIFFERENT METABOLIC CONDITIONS. Noack, D. (Institut fuer Mikrobiologie und Experimentelle Therapie, Jena, Ger.). Radiobiol. Radiotherap., 7: 503-6(1966). (In German).

Results are reported from a study on the effects of metabolic conditions on the uv induction of the prophage of E. coli K 12. (C.H.)

Radiosterilization and Radiopreservation

14779 MODERN METHODS OF FOOD PRESERVATION. Bosund, Ingmar (Nordreco AB, Bjuv, Sweden). Svensk Kem. Tidskr., 78: 413-31(1966). (In Swedish).

Advances in the use of ionizing radiation for food pasteurization and sterilization are reviewed, along with other new processes for preservation of foodstuffs. Processes employing ^{60}Co or ^{137}Cs sources were studied to the greatest extent, but electron accelerators were also used for high-energy irradiation of some products. Side-effects produced when high sterilizing radiation doses are used are discussed, and bacon is cited as an example of successful use of this procedure. Pasteurization doses are better tolerated, with less objectionable changes in color, flavor, and texture. Use of heat combined with radiation to eliminate some of the most radioresistant microorganisms is discussed. Use of radiation for eliminating pests from stored products and to reduce sprouting of some vegetables, such as potatoes, is also considered. Doses employed in these applications generally do not impart objectionable qualities in the product. Status of radiopasteurization research in various countries is briefly mentioned. (BBB)

14780 PRESERVATION OF FRESH UNFROZEN FISHERY PRODUCTS BY LOW-LEVEL RADIATION. IV. ORGANOLEPTIC STUDIES ON RADIATION-PASTEURIZED SKINLESS HADDOCK FILLETS. Connors, Thomas J.; Steinberg, Maynard A. (Bureau of Commercial Fisheries Technological Lab., Gloucester, Mass.). Food Technol., 20: 117-19(Oct. 1966).

The effects of irradiation dose, storage temperature, and packaging atmosphere on the quality and shelf life of haddock fillets were studied. Packing skinless haddock fillets in cans and irradiating at 150,000, 250,000, and 350,000 rad extended their commercial life at 33°F from about 12 days to at least 30 days. At 42°F, spoilage occurred between the 20th and 30th days of storage. For air-packed haddock fillets, irradiation at 250,000 rad resulted in a product less different from fresh-frozen unirradiated fillets than did treatment at 150,000 or 350,000 rad. For vacuum-packed haddock fillets, irradiation at 150,000 rad resulted in a product less different from fresh-frozen unirradiated fillets than did irradiation at 250,000 or 350,000 rad. After 20 days' storage at 33°F, airpacked haddock fillets irradiated at 250,000 rad were very nearly as acceptable as freshly frozen unirradiated haddock fillets. After 30 days at 33°F, these fillets were still acceptable, but less so than the unirradiated frozen controls. The acceptability of vacuum-packed samples irradiated at 150,000 rad was closely comparable to that of the frozen controls throughout the 30-day storage period. (BBB)

14781 PRESERVATION OF FRESH UNFROZEN FISHERY PRODUCTS BY LOW-LEVEL RADIATION. 5. THE EFFECTS OF RADIATION PASTEURIZATION ON AMINO ACIDS AND VITAMINS IN HADDOCK FILLETS. Brooke, Richard O.; Ravesi, Elinor M.; Gadbois, Donald F.; Steinberg, Maynard A. (Bureau of Commercial Fisheries Tech. Lab., Glocester, Mass.). Food Technol., 20: 99-102(Nov. 1966).

A study was made: to determine the effects of ^{60}Co γ irradiation and storage under various conditions on the amino acids and B vitamins of haddock fillets; to compare these findings with any changes that result from commercial practices of storage of fresh fillets in ice for 10 days and frozen fillets at –5°F for 12 months; and to evaluate the effects on these constituents of irradiation at levels 10 times the maximum recommended to determine whether major losses occur under extreme conditions. Storage in ice or at –5°F had no effect on amino acids in haddock fillets analyzed in the raw state and after steaming. This also was true when haddock fillets were: air-packed, irradiated at 250,000 rad, and stored 30 days at 33°F; vacuum-packed, irradiated at 150,000 rad, and stored 30 days at 33°F; or air-packed, irradiated at 2,500,000 rad, and not subsequently stored. Analyses of 29 samples of fresh haddock fillets for 19 amino acids were used to establish the normal variation. Irradiation at the high level of 2,500,000 rad caused slight losses of riboflavin and thiamin; but, with the exception of riboflavin, irradiation at 2,500,000 rad caused no losses that were not comparable to those occurring in haddock fillets stored on ice for 5 days and 10 days at –5°F for 6 and 12 months. The basis of comparison was analyses of 10 samples of fresh haddock fillets for riboflavin, thiamin, niacin, pyridoxine, pantothenic acid, and vitamin B_{12}. (BBB)

14782 CALCULATION OF INDUCED RADIOACTIVITY IN ELECTRON STERILIZED FOOD. Meyer, R. A. (Army Natick Labs., Mass.); Burkhardt, J. L. Health Phys., 12: 1581-7(Nov. 1966).

The basis for a tractable equation to predict the amount of radioactivity induced in food from high energy electron sterilization is shown. This equation yields results which are in agreement with previous experimental results. Also, it appears that by using thin plastic packaging the threshold of detectable induced activity may be raised to as high as 17 or 18 Mev. (auth)

14783 CHANGES IN THE MICROFLORA OF VACUUM-PACKAGED, IRRADIATED PETRALE SOLE (EOPSETTA JORDANI) FILLETS STORED AT 0.5 C. Pelroy, Gretchen A.; Eklund, Melvin W. (Bureau of Commercial Fisheries, Seattle). Appl. Microbiol., 14: 921-7(Nov. 1966).

The microfloral changes of irradiated petrale sole fillets during anaerobic (vacuum-packed in cans) refrigerated storage was determined by the identification of 1,260 microbial isolates to the generic level. The samples were irradiated at 0.0, 0.1, 0.2, 0.3, and 0.4 Mrad from a ^{60}Co γ source, stored at 0.5°C, and examined periodically for spoilage and total microbial population and composition. The preirradiation flora consisted of Achromobacter, Micrococcus, Pseudomonas, coryneforms, Lactobacillus, and Flavobacterium. Immediately after irradiation, Micrococcus, Achromobacter, coryneforms, and Bacillus were predominant. After storage under vacuum, the spoilage flora of the nonirradiated petrale sole was predominantly Pseudomonas; the spoilage flora of the 0.1-Mrad irradiated samples consisted of Pseudomonas and Lactobacillus; and that of the 0.2-, 0.3-, and 0.4-Mrad samples was almost entirely Lactobacillus. (auth)

14784 PRESERVATION OF CHEESE WITH COMBINED USE OF GAMMA RAYS AND SORBIC ACID. Bongirwar, D. R.; Kumta, U. S. (Atomic Energy Establishment, Trombay, India). Int. J. Appl. Radiat. Isotop., 18: 133-4(Feb. 1967).

Cheese was chosen as a typical milk product readily attacked by molds. Cobalt-60 gamma irradiation was employed, together with sorbic acid coated cellophane wrappers shown to inhibit surface mold growth. Sorbic acid is suitable for milk products because of its high partition coefficient towards oil/water and its low dissociation constant. The wrapped cheese was sealed in polythene bags, in a nitrogen atmosphere, to exclude oxygen, since irradiation is known to produce more carbonyl compounds in the presence of oxygen. Irradiation to 0.2 Mrad did not produce any "off flavor", but a "coconut-like" flavor was noticeable with samples exposed to 0.5 Mrad. For most of the experimental work a dose of 0.1 Mrad and sorbic acid coated wrappers (0.5% solution, sprayed four times) were employed. There was a marked synergistic effect on shelf-life of the cheese when stored at 37°C, but less so at room temperature and below. The samples retained their organoleptic attributes and were found acceptable. When binding substances were used together with sorbic acid for wrapper coating there was a further increase in shelf-life. Although the radiation doses employed were not lethal to molds, it is likely that they may cause permeability changes, thereby increasing the fungistatic effect of the sorbic acid. (auth)

14785 EFFECT OF γ IRRADIATION ON THE MICROFLORA OF FRESHWATER FISH. II. GENERIC IDENTIFICATION OF AEROBIC BACTERIA FROM YELLOW PERCH FILLETS. Kazanas, N. (Bureau of Commercial Fisheries, Ann Arbor, Mich.). Appl. Microbiol., 14: 957-65(Nov. 1966).

Studies on the generic identification of bacteria isolated from nonirradiated and γ irradiated (0.3 and 0.6 Mrad) yellow perch fillets during the course of microbial spoilage were conducted. After the enumeration and tabulation of macrocolonies on petri dish cultures obtained from fillets, isolates were examined and keyed out essentially according to modified morphological and biochemical protocols of Shewan. Identification was further confirmed through reference to Bergey's Manual. Data obtained from each isolate were coded and recorded on IBM cards to facilitate identification. Total aerobic microbial plate counts obtained from nonirradiated perch before storage ranged from 10^5 to 10^6 microorganisms per gram of fish. Organisms isolated

from these fillets, in order of decreasing number, consisted of Achromobacter, Alcaligenes, Pseudomonas, Brevibacterium, Micrococcus, Flavobacterium, Bacillus, Sarcina, Microbacterium, Corynebacterium, yeasts, Lactobacillus, Vibrio, Aeromonas, and a few Proteus and Escherichia cells. During storage and as spoilage progressed, the flora shifted and the pseudomonads became predominant. Irradiation of fillets to 0.3 and 0.6 Mrad reduced the aforementioned flora to the Achromobacter-Alcaligenes group, which constituted the residual flora throughout fillet storage. (auth)

14786 CONCERNING THE POSSIBLE DANGERS FOR THE CONSUMER CAUSED BY CONSERVATION OF FOODS BY IRRADIATION. **Tuchscheerer, Th.; Peter, G. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). Atompraxis, 12: 573-6(Nov. 1966). (In German).**

In comparison with the maximum permissible concentration, the possible danger of irradiated food for the consumer is estimated. The particular significance of long-lived radioisotopes originated by preservation of food by irradiation is pointed out. If the products are irradiated with 20 MeV radiation energy, and under the condition that only irradiated products are consumed, the necessary storage time is 4 to 5 days. The possibilities for reducing storage times are discussed. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 14178, 14857, and 14885.

14787 (RFP–879) CLEANING AN IDEAL BERYLLIUM SURFACE. Adams, R. O. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Feb. 14, 1967. Contract AT(29-1)-1106. 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A (0001) plane of a Be single crystal is arbitrarily defined as an ideal Be surface. Requirements for cleaning this surface were established. It was found necessary to heat the crystal to 1000°C to produce a clean surface. Sputtering for 30 minutes, with 1000 eV argon ions, also cleaned the surface as well as the 1000°C heating did. (auth)

14788 CLADDING AND STRUCTURAL MATERIALS. Reactor Mater., 9: 174-96(Fall 1966).

Recent technical developments in cladding and structural materials discussed under the headings corrosion, metal-water reactions, selected mechanical properties of cladding and structural materials, selected metallurgical aspects of cladding and structural materials, diffusion studies, radiation effects in nonfuel materials, and ceramic technology. The corrosion studies include reviews of the corrosion of Zr-alloys, stainless steel, and base metals by liquid metals, such as Na, NaK, K, Hg, and other nonalkali liquid metals, e.g., Cd, Pb, Sn, and Zn and by reprocessing solutions. The metal-water reactions section reviews the effects of various factors on the reactions between steam and stainless steels. The mechanical properties of Al, Ni-base alloys, steels, refractory metals and alloys, and Zr are reviewed. The metallurgical aspects of the light metals, Al and Mg and their alloys, Al–Al_2O_3, Mg-base–Zr, Ti–Al, Mo–V, Zr and Zr alloys, Fe alloys, Ni alloys, and refractory metals. The radiation effects on stainless steel, low-alloy steels, Ni-base alloys and Zr alloys are reviewed. (109 references). (B.L.M.)

Corrosion and Erosion

Refer also to abstracts 14820 and 14844.

14789 (EURAEC–1619) A SURVEY OF SOME METAL OXIDATION PROBLEMS. Quarterly Report No. 13, January 1–March 31, 1966. (Brussels Univ. (Belgium)). Contract 079-64-10TEEB. 12p. (EUR–2832). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Developments in studies on the controlled oxidation of Al and iodation of Cu are reported. The existence of a period of incubation followed by a period of nucleus growth and finally by a period of continuous layer growth was found in the oxidation of Al. The effects of crystalline force, reactor temperature, and pressure are discussed. The most favorable conditions found for the iodation of copper were 340°C and a partial pressure of 0.23 mm Hg. The existence of a continuous layer preceding nucleation was also found. The possible effects of layer thickness are discussed. (P.C.H.)

14790 (KR–112) IRRADIATION EXPERIENCE WITH THE FIRST UO_2 ALUMINIUM CLAD FUEL ELEMENT TESTED IN HBWR. Videm, K.; Aas, S.; Hanevik, A.; Jensen, E. (Institutt for Atomenergi, Kjeller (Norway)). Sept. 1966. 25p. Dep. mn.

Reactor experience with the first Al clad fuel element tested under HBWR conditions, (230°C, 28 kg/cm^2), is described. The cladding alloy used had the following composition: 1% Ni, 11% Si, 0.5% Fe, 0.8% Mg, 0.1% Ti, Bal.Al. After a total irradiation time of 140 days, corresponding to an integrated power of 730 MWd/t at two channel power levels, one of the stringers failed at two bulb-shaped distortions, one at either end of the stringer. The primary reason for the failure was corrosion of accidental inclusions of pure Al in the Al alloy cladding. The bulb-shaped distortions were caused by reaction between the thermal isolation pellets of MgO and the in-leaked water. The general behavior of the other stringers was satisfactory. Based on the experience with these elements two new assemblies have been made and are being irradiated. The maximum heat fluxes are 65 and 140 W/cm^2 respectively, and the integrated powers 5900 and 6500 MWd/t as of August 1, 1966. (auth)

14791 MASS TRANSFER OF NIOBIUM-BASE ALLOYS IN FLOWING NONISOTHERMAL LITHIUM. DeVan, J. H.; Sessions, C. E. (Oak Ridge National Lab., Tenn.). Nucl. Appl., 3: 102-9(Feb. 1967).

Mass transfer rates of Nb–1%Zr and D-43 (Nb–10%W–1%Zr–0.1%C) in high-temperature Li were determined in thermal convection loops of each alloy. The loops circulated Li for 3000 hr at a 1200°C maximum temperature and a 100 to 150°C ΔT. Weight change data were obtained from 58 insert specimens placed end-to-end around each loop. The oxygen content of both alloys decreased during test. Zr and N_2 were transferred by the Li from the higher-temperature to the lower-temperature loop surfaces. The extent of this mass transfer was greater in the Nb–1%Zr test and resulted in a light zirconium–nitride mass transfer deposit on the cold-leg surfaces of this alloy. Specimens at equivalent temperatures in the heater and cooler regions showed the same weight change indicating no appreciable downstream effect due to concentration changes in the Li. Given the same absolute concentration driving force, the rate of deposition was measurably greater than the rate of dissolution; accordingly, dissolution occurred over two-thirds of the loop surfaces and deposition over the remaining one-third. An analysis of the mass transfer results for these two loops based on the assumption of a simple dissolution model showed the change in solute concentration of the Li around the loop to be only a few parts per billion. (auth)

14792 CARBON AND NITROGEN TRANSFER IN A TYPE-316 STAINLESS-STEEL, Cb–1 PERCENT Zr, LIQUID-POTASSIUM SYSTEM. Goldmann, K.; Hyman, N.; Kostman, S.; McKee, J. (United Nuclear Corp., White Plains, N. Y.). Nucl. Appl., 3: 117-26(Feb. 1967).

Data are presented on carbon and nitrogen transfer by K in 16 stainless steel thermal convection loops containing Nb–1%Zr and stainless steel tabs. Typical test conditions were 5000 hr at 1600°F maximum, 1200°F minimum. Changes in weight, composition, and microstructure of both tab materials were determined as a function of time over the full temperature range. Changes in loop wall composition, microstructure, and tensile properties were determined at the end of the test. The Nb–1%Zr formed thin carbide and nitride surface films at a rate limited by diffusion through the films rather than by availability of carbon and nitrogen in the potassium. Cold bend tests showed good ductility in Nb–1%Zr after 5000 hr. Transfer of carbon and nitrogen from hot to cold stainless steel was unaffected by the Nb–1%Zr and had less effect on tensile properties than microstructural changes associated with the thermal history. (auth)

14793 EVALUATION OF Li, Na, K, Rb, AND Cs BOILING AND CONDENSING IN Nb–1 PERCENT Zr CAPSULES. Romano, A. J.; Fleitman, A. H.; Klamut, C. J. (Brookhaven National Lab., Upton, N. Y.). Nucl. Appl., 3: 110-16(Feb. 1967). (BNL–9922).

A Nb–1%Zr alloy was tested as a possible container material for alkali coolants and working fluids in space power plants utilizing the Rankine cycle. Li, Na, K, Rb, and Cs were tested in Nb–1%Zr capsules at 1150°C for 6000 hr in a vacuum chamber at a pressure of $<5 \times 10^{-8}$ torr. It was demonstrated that by maintaining low oxygen levels in the alkali-metal Nb–1%Zr systems, there was no corrosion detected in any system. However, when Na was tested in Nb–1%Zr containing in excess of 1500 ppM O at 1094°C for 10,000 hr, significant corrosion was detected. (J.G.B.)

14794 CORROSION STUDIES OF TUNGSTEN, MOLYBDENUM, AND RHENIUM IN LITHIUM. De Mastry, J. A. (Battelle Memorial Inst., Columbus, Ohio). Nucl. Appl., 3: 127-34(Feb. 1967).

The compatibility of W, W–0.9 wt % Nb, W–10 wt % Re, W–25 wt % Re, TZM (Mo–0.5 wt % Ti–0.08 wt % Zr), Mo–50 wt % Re, and Re in static Li was determined. Exposures were at 2500, 2800, and 3000°F for periods of 100 and 1000 hr. Exposures were conducted in TZM containers for all alloys tested. The results obtained must be viewed in light of the dissimilar capsule employed. The W-base materials were not attacked by Li after 100- or 1000-hr exposure at 2500°F. At 2800°F, all of the W-base materials exhibited varying degrees of surface dissolution and grain-boundary penetration. TZM and Mo–50 wt % Re alloys were resistant to attack by Li at up to 3000°F for 100- and 1000-hr exposure. Unalloyed Re underwent dissimilar metal interaction while immersed in Li in TZM test capsules for 1000 hr at 2500°F and 100 hr at 3000°F. Mo was transferred from the TZM corrosion capsule to the Re where alloying occurred. (auth)

14795 THE CHEMICAL NATURE OF THE CHROMIUM OXIDE AEROSOL PRODUCED BY HEATED 80:20 NICKEL–CHROMIUM ALLOY. Goldsmith, P.; May, F. G. (Atomic Energy Research Establishment, Harwell, Eng.). Brit. Corros. J., 1: 323-6(Sept. 1966).

Investigations were carried out on the amounts of Cr aerosol

produced by heating Ni–Cr as a function of temperature and the proportion of that Cr in the form of CrO_3. A 80:20 Ni–Cr ribbon was irradiated in a reactor for 28 days at a flux of about 1.2×10^{12} neutrons cm^{-2} sec^{-1}. The γ emission from the wire immediately after irradiation was due mainly to the short-lived neutron-induced isotopes such as ^{65}Ni and ^{56}Mn. After the wire radioactivity was allowed to decay for 2 weeks the remaining activity was due mainly to the longer-lived isotopes ^{51}Cr, ^{58}Co, and ^{60}Co. Clean air was passed over the heated wire and through a filter for 10 and 200 min. The emitted aerosol was collected on the filter which was subsequently γ counted and the associated ^{51}Cr determined. The corrosion of heated 80:20 Ni–Cr at temperatures between 950 and 1250°C was thus shown to be accompanied by emission of submicron particles. These particles are composed of Cr in the form of an oxide. Evidence is presented using neutron activation techniques that between 46 and 68% of the emitted Cr is in the form of CrO_3. The rates of emission of Cr at different temperatures over comparatively short periods of time were also measured using the same technique. The production of Cr (aerosol) from the wire was very temperature-dependent as expected, the output of Cr roughly doubling for each 40° rise in temperature. (BBB)

14796 SOLID-PHASE SURFACE REACTIONS AMONG BORIDES, HIGH-MELTING-POINT METALS, AND ZrO_2. Samsonov, G. V.; Strashinskaya, L. V. (Inst. of Material Science Problems, Academy of Sciences, Ukrainian SSR). pp 437-44 of Vysokotemperaturnye Neorganicheskie Soedineniya. Samsonov, G. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1965. (In Russian).

The interaction between powdered borides (TiB_2, ZrB_2, TaB_2, Mo_2B_5, W_2B_5) and compressed high-temperature metals (Nb, Ta, Mo, W) during heating for 5 hours at 1000 to 2100°C and 5×10^{-2} mm Hg and between hot-pressed TiB_2 and ZrB_2 with ZrO_2 for 2 to 5 hours at 1000 to 1500°C and 5×10^{-2} mm Hg was studied by metallographic and microhardness techniques. It was found that (depending upon the extent of interface diffusion) the microhardness of the new phase formed during boride–metal interaction varies between 1000 and 4000×10^6 dyne/mm^2. It was found that of all the borides, TiB_2 interacted least with the high-temperature metals. The dependence of the microhardness of tantalum borides upon boron content is graphed. A table gives the temperatures at which the reaction among the borides, high-temperature metals, and ZrO_2 in vacuum commences. (ATD)

14797 STUDY ON THE BEHAVIOR OF LIGHT ALLOYS UNDER WATER CORROSION CONDITIONS. Pelras, M. (CEN, Saclay, Gif-sur-Yvette, France). Corros. Anti-Corros., 14: 363-74(Dec. 1966). (In French).

The corrosion of aluminum, magnesium, and their alloys by water at low and high temperatures was studied. Studies were also made on the use of corrosion inhibitors and the influence of chlorides and couplings on magnesium and its alloys. (J.G.B.)

14798 STUDY OF THE BEHAVIOR OF ZIRCONIUM ALLOYS IN HIGH TEMPERATURE WATER AND IN SUPERHEATED STEAM. Coriou, H. (CEN, Saclay, Gif-sur-Yvette, France). Corros. Anti-Corros., 14: 351-62(Dec. 1966). (In French).

The aqueous corrosion behavior of unalloyed Zr was studied. The lower resistance of high-purity Zr in high temperature water (360°C) and in superheated steam (400°C) is reported, as compared with that of commercial Kroll Zr. The corrosion properties of Zircaloys 2 and 4 are reviewed, and the influence of irradiation on the corrosion behavior of these alloys is examined. The possibility of using Zr alloys in superheated steam at temperatures of about 500°C is discussed. (auth)

Preparation and Fabrication

14799 (ANL-7206) VANADIUM ALLOY SCREENING STUDIES AND FABRICATION OF V-15 WT. PERCENT Ti-7.5 WT. PERCENT Cr TUBING FOR NUCLEAR FUEL CLADDING. Kramer, W. C.; Burt, W. R. Jr.; Karasek, F. J.; Flinn, J. E.; Mayfield, R. M. (Argonne National Lab., Ill.). Aug. 1966. Contract W-31-109-eng-38. 60p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Based on results of screening tests involving a number of alloys, the V–15 wt % Ti–7.5 wt % Cr alloy emerged as a promising cladding candidate for Na-cooled fast reactors. "Scale-up" or pilot-plant production technology is presented for this alloy. Consolidation involved consumable arc-melting of compacted electrodes, followed by arc-remelting. The double-melted ingots were broken down by extrusion, followed by re-extrusion into rod, sheet-bar, and tube-blanks. Rod and sheet products were easily cold-rolled to finished sizes. Extruded tube-blanks were processed by swaging, tube-reducing, and drawing. Some early processing problems were solved, and high yields were realized in the production of reactor-grade tubing. Results of annealing studies and property tests are presented and discussed. (auth)

14800 (N-66-26238) DEVELOPMENT OF FABRICATION PROCESS FOR METALLIC FIBERS OF REFRACTORY METAL ALLOYS. Six Month Progress Report. Amra, L. H.; Chamberlain, L. F.; Adams, F. R.; Tavernelli, J. F.; Polanka, G. J. (General Electric Co., Cleveland, Ohio. Lamp Metals and Components Dept.). Jan. 20, 1966. Contract NAS3-7906. 99p. (NASA-CR-75015). CFSTI $3.00 cy, $0.65 mn.

The six refractory metal alloy systems under study are: TZC, AS-30, W–Re–ThO_2, W–Hf–C, FS-85, and T-222. The strength goal for these wires is a stress-to-density ratio of 125,000 inches for a rupture life of 3,000 hours in a temperature range of 2000 to 2200°F. A small amount of TZC alloy wire at 5 mils diameter has been produced by working down vacuum cast ingots. The AS-30 alloy has been melted. Considerable difficulty has occurred in attempts to produce workable W alloy bars from pressed and sintered powders, in both W systems. However, recent efforts with the W–Re–ThO_2 system are very encouraging. The other part of the task contracted for, the designing and building of a six station creep, stress-rupture test equipment, has progressed to the building stage. (auth)

14801 (ORNL-P-2745) THERMOCHEMICAL DEPOSITION AND EVALUATION OF RHENIUM AND TUNGSTEN–RHENIUM ALLOYS. Federer, J. I.; Schaffhauser, A. C.; Leitten, C. F. Jr. (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26. 7p. (CONF-661116-4). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Thermionic Conversion Specialist Conference, Houston, Tex.

Re and W–Re alloys have been deposited by H_2 reduction of WR_6 and ReF_6 at low pressures. W-rich alloys having compositional uniformity in both the axial and radial direction of tubular deposits were obtained at 600 to 900°C. An embrittling β-W phase in W–rich alloys was dissolved by annealing at 2000°C. As-deposited W–rich alloys have a strong orientation of (100) parallel to the substrate whether single phase solid solution, single phase β-W, or a mixture of these phases. Smooth, dense, Re coatings deposited at 600°C have a strong orientation of basal planes parallel to the substrate. (auth)

14802 (RFP-686) LOW-ENERGY ACCELERATED ION DEPOSITION. Baum, G. A. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Feb. 6, 1967. Contract AT(29-1)-1106. 11p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A low energy accelerated ion vapor deposition technique is described which provides superior film adherence when compared to the more common vapor deposition techniques. The significant feature is the ionization of the depositing species by an electron reinforced gas discharge and subsequent acceleration into a substrate held at a low negative potential. In addition to good film adherence, this technique provides a low sputtering rate and only moderate substrate heating. (auth)

14803 POSSIBILITIES OF EVAPORATION-DEPOSITING THIN LAYERS OF TANTALUM FROM THE LIQUID PHASE BY MEANS OF ELECTRON BOMBARDMENT. Zelechowski, Bartlomiej. Przegl. Elektron., 7: 539-40(Nov. 1966). (In Polish).

The properties of thin layers of Ta are presented for the formation of very rugged and very stable resistors, conductors, and capacitors. For the latter case, the layer of Ta may be oxidized to form a thin coating of dielectric. Many problems of Ta deposition stem from the 3027°C melting point of Ta. The principal advantage of the methods of depositing Ta described is the attainment of a small volume of molten Ta, which reduces heating problems usually encountered in the more conventional method of heating Ta in a crucible and which greatly reduces the vacuum problems. As a result, a simple, inexpensive vacuum system can be used. The Ta is located either on a thin W wire or is placed in the form of a sheet of pure Ta (the latter method is preferred for obtaining very pure Ta deposits with a minimum of vacuum-system problems) near a heated cathode, which partially surrounds it. The Ta, forming the anode, has a high voltage applied to it which is about 1-keV or less. The heating of the Ta is regulated by the cathode-to-anode voltage; the electron current is on the order of 450 ma. This serves as a rapid means of controlling the power deposited on the small Ta bead (that soon forms because of surface tension of the molten metal) by the electron current, and of thereby controlling the evaporation rate. (TTT)

14804 DIFFUSION BRAZING IN STAINLESS STEEL FUEL ELEMENTS FOR WATER COOLED POWER REACTORS. Amato, I.; Colombo, R. L.; Gatti, S. (FIAT, Sezione Energia Nucleare, Turin). Energ. Nucl. (Milan), 14: 182-5(Mar. 1967).

The influence of temperature and soaking time on the proper-

ties of brazed bonds between stainless steel tubes was investigated. Five tube slugs were brazed in high-purity hydrogen for 1 to 20 hrs at temperatures ranging from 1025 to 1100°C. The pieces were submitted to tensile tests along a diagonal with plugs inserted in each in order to avoid warping. The results showed that the strength of the bond increased with temperatures up to 1075°C, but decreased at 1100°C; the strength of the bond increased with soaking time, but the increase was negligible after 10 hr (however, rapid grain growth took place in the base metal at these temperatures). Diffusion bonding took place with the shortest treatment at the lowest temperature. While the melted zone remained largely unaffected, soaking time and, more effectively, temperature, enlarged the diffusion zone. Microhardness tests showed that in general the diffusion zone was slightly harder than the base metal, while the melted zone was considerably softer. (D.H.M.)

14805 PRODUCTION OF URANIUM, THORIUM, AND PLUTONIUM AND THEIR COMPOUNDS. Barghusen, J. J. Reactor Fuel Process., 9: 237-42(Fall 1966).

Various processes for the production of uranium, thorium, and plutonium are discussed. Some methods for the production of uranium compounds by hydrometallurgical techniques, the production of uranium compounds by gas–solid reactions, the production of plutonium metal, the production of plutonium compounds from plutonium dioxide, and the production of thorium and thorium dioxide are included. (D.H.M.)

14806 FABRICATION OF COMPLEX BERYLLIUM SHAPES BY GAS-PRESSURE COMPACTION. Hanes, H. D.; Gripshover, P. J.; Hodge, E. S. (Battelle Memorial Inst., Columbus, Ohio). Planseeber. Pulvermet., 14: 153-64(Dec. 1966).

The gas-pressure-bonding process was used as a technique for hot isostatically pressing Be powder into complex shapes. The process used high inert-gas pressures to force the particles into intimate contact, and elevated temperatures to promote interparticle bonding. Because of the high pressure used, 10,000 to 15,000 psi, full densification was achieved at 750°C., thus maintaining a fine grain size in commercial powders. The isostatic pressure application allowed the densification of complex configurations, and machining operations were minimized. Be powder was preformed by vibratory packing, cold-hydrostatic pressing, plasma-arc spraying, or explosive compaction. The preform was then loaded and sealed in an expendable, thin-gage, mild steel container. Internal cavities were formed by Cu or Ni mandrels, which were removed after gas-pressure compaction by selective leaching. Specimens with complex external surfaces were packed in a NaCl pressure-transmitting layer to allow canning in simple containers. A variety of Be shapes were gas-pressure compacted by means of these techniques. Included were simple tubes and rods, duplex and fluted tubes, and various gyro components. (auth)

14807 A NEW TYPE OF SUPERCONDUCTING Nb_3Sn-TAPE. Maier, Richard Georg (Siemens-Schuckertwerke AG, Erlangen, Ger.). Z. Metallk., 57: 874-6(Dec. 1966). (In German).

A review is given about the possibilities to fabricate tape- or wire-superconductors based on Nb_3Sn. The advantage of the system Nb–Sn to prepare thin superconductors by diffusion is discussed. Finally a fabrication method for superconducting tape with films of Nb_3Sn is reported. The critical data and some mechanical properties of this material together with results on test coils, show the usefulness of this tape to construct superconducting solenoids. (auth)

14808 SPECIAL FABRICATION TECHNIQUES. Reactor Mater., 9: 197-202(Fall 1966).

Recent developments in special fabrication techniques applying various types of reactor materials are reviewed. The melting, casting, and fabrication of carbides of U are considered in detail. A coextrusion technique for bonding Al to Zircaloy-2 is considered. The rolling, swaging, and coextrusion techniques are also considered with relation to Nb-type 316 stainless steel, to Zircaloy-clad U-core tubular elements for use as potential fuels for a heavy-water-moderated and -cooled power reactor, and to Th–^{235}U fuel tubes for breeder fuel. Certain electroplating, electroreduction, and electroprecipitation techniques, as well as nonelectrolytic chemical plating, are reviewed. A method is described for the fabrication of isotropic high-density graphite by gas-pressure bonding. An ultrasonic method of nondestructive testing for metallic specimens is reviewed. (27 references). (B.L.M.)

14809 OPTIMIZING HEAT TREATMENTS FOR PRECIPITATION HARDENING SUPERALLOYS. MacFarlane, Richard R.; Whitney, C. Raymond (Carpenter Steel Co., Reading, Pa.). Metal Progr., 91: No. 2, 75-8(Feb. 1967).

A method is presented for more efficient heat treatment for Pyromet 860, an Fe–Ni-base high-temperature alloy. Use of mathematics lessened the number of tests needed to develop and verify the procedure. Using these principles an exact, quantitative approach can determine a select aging time and temperature that will yield a maximum in one specific mechanical property or a preferred combination of properties. (P.C.S.)

14810 DIFFUSION BONDING BERYLLIUM, MOLYBDENUM, AND TUNGSTEN. D'Annessa, Anthony T. (Lockheed-Georgia Research Labs., Marietta). Metal Progr., 91: No. 2, 71-4(Feb. 1967).

Dissimilar metal foils were used to promote interdiffusion below base-metal recrystallization temperatures. Selected post-bond diffusion treatments were used to metallurgically "tailor" a joint for a given thermal environment or to assess diffusion damage. The effects of Al and Cu foils on the bonding properties of Be, of Ni and Ti on Mo alloys, and of Nb and Ni on W alloys are discussed. Disadvantages are given. (P.C.S.)

14811 POLISHING BERYLLIUM BY VIBRATION. Danforth, Arthur L.; Krashes, David (Massachusetts Materials Research, Inc., Worcester). Metal Progr., 91: No. 2, 115(Feb. 1967).

A method was developed for vibratory polishing of cast Be using a heavy slurry of chromic oxides. It provided excellent metallographic specimens for Be alloys and wrought Be also. (P.C.S.)

14812 IN VACUO DIFFUSION BONDING OF INFUSIBLE COMPOUNDS CONTAINING HIGH-TEMPERATURE METALS. Burykina, A. L.; Evtushenko, O. V. (Inst. of Materials Science Problems, Academy of Sciences, Ukrainian SSR). pp 76-80 of Vysokotemperaturnye Neorganicheskie Soedineniya. Samsonov, G. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1965. (In Russian).

The conditions for diffusion bonding of Zr, Nb, and Ta carbides with Nb, Ta, Mo, and W, and of Ti, Mo, and W between themselves and of Mo and W alone were investigated. The experiments were conducted at 1200 to 2000°C, 5 to 15 Newtons/mm^2 pressure, and 10 to 60 min duration using the apparatus shown. Results are summarized in a table. (ATD)

14813 GAS-PHASE BORIDING OF HIGH-ALLOY STEELS. Pchelkina, M. A. (Moscow Highway Inst.). pp 81-7 of Vysokotemperaturnye Neorganicheskie Soedineniya. Samsonov, G. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1965. (In Russian).

Gas-phase boriding of a series of commercial-grade high-alloy steels was studied in order to examine the influence of individual steel components on composition of the upper steel layer, mechanism of its formation, and depth and properties of the borided layer. The steel samples contained 0.27 to 0.51% C, 1.06 to 25.50% Cr, 2.17 to 12.82% Ni, 2.05 to 2.30% W, 1.95 to 7.90% Mn, 0.60 to 1.54% Nb, and 1.9 to 3.5% Ti. The boriding was effected by treatment of steel samples with a B_2H_6–H_2 mixture (B_2H_6:H_2 = 1:25) at 950°C for 6 hours. All steels except high-chromium ones exhibited austenite structure after boration. The borided high-chromium steels had mixed α- and β-phase structures. The effect of chromium content on depth of the borided layer is shown in a figure. The results are summarized in a table. (ATD)

14814 RESEARCHES IN POWDER METALLURGY. Borok, B. A. (ed.). New York, Plenum Publishing Corporation, 1966. 154p. $22.50.

Translated from Poroshkovaya Metallurgiya by Z. S. Michalewicz.

Eighteen separate papers are presented which are concerned with the following topics: powder preparation, compacting, sintering of Ni materials, and sintering of Mo materials. The theory and practice of the preparation of alloy powders by the simultaneous reduction of oxide mixtures with CaH_2 are described in considerable detail. The properties of the resulting powders and the parts manufactured from them are considered. Methods for the production of semiproducts, such as billets, rods, tubes, and sheets that are difficult to produce by orthodox techniques are discussed. Not only the sintering of Ni and Mo materials, but other aspects of their preparation as well as the properties of the resulting alloys are presented. (B.L.M.)

Properties Evaluations

14815 (AMRA-TR-66-13) NOTCHED PROPERTIES OF HIGH-STRENGTH ALLOYS AT VARIOUS LOAD RATES AND TEMPERATURES. Iannelli, Armando A.; Rizzitano, F. J. (Army Materials Research Agency, Watertown Arsenal, Mass.). July 1966. 16p. CFSTI $3.00 cy, $0.65 mn.

Tests have been conducted to determine the notched and unnotched strengths of Al alloys 7001-T6 and 7075-T6, Ti alloy 6Al–6V–2Sn, U alloy 8Mo–0.5 Ti, Rocoloy steels, and 18% Ni maraging steel at load durations of 10 milliseconds to 5 minutes, and at temperatures from –320 to 500°F. At room temperatures, as load

duration was increased from 10 milliseconds to 5 minutes, the notched and unnotched tensile strengths of these materials were maintained within 10 percent, except that they increased approximately 30 percent for the notched Al alloys, and decreased 30 percent for the unnotched U alloy. The notched strength of Rocoloy steel was less than its unnotched strength over the entire test temperature range. Notched strengths of all the other alloys tested were less than their unnotched strengths in the lower test temperature range but exceeded the unnotched strengths in the higher temperature range. (auth)

14816 (BMI-1793) INVESTIGATION OF THE INITIATION AND EXTENT OF DUCTILE PIPE RUPTURE. Progress Report, May-December 1966. Eiber, Robert J.; Hein, Glen M.; Duffy, Arthur R.; Atterbury, T. J. (Battelle Memorial Inst., Columbus, Ohio). Jan. 1, 1967. Contract W-7405-eng-92. 26p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments in studies to determine what size defects in typical reactor-coolant piping are required to produce unstable propagating fractures under boiling-water and pressurized-water reactor conditions are reported. Theoretical formulations for predicting the failure stresses of through-the-wall and surface defects as a function of a critical-stress-intensity factor are presented. These formulations were found to provide accurate predictions of failure stresses in relatively thin-wall Al and steel pressure vessels containing defects. The experimental programs for full-scale and laboratory tests are described. (P.C.H.)

14817 (EURAEC-1499) STUDY OF PARENT METAL FOR USE IN RESEARCH INTO BRITTLE FRACTURE OF LARGE WELDMENTS. Quarterly Report No. 6, July 1-September 30, 1965. (Institut de Recherches de la Siderurgie, St. Germaine-en-Laye (France)). Oct. 1965. 20p. (EUR-2657). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States-Euratom Joint Research and Development Program.

Studies were made on the anisothermal stress relieving and structural transformations in Super ELSO steel and Jominy quenchability and mechanical properties of AMMO steel. The optimum stress relieving treatment for the different tests performed was at a maximum temperature of 600°C, with a time at temperature of more than 2 hr. The influence of the heating temperature on transformations during rapid thermal cycling was noted. Tests on the Jominy quenchability and mechanical properties of AMMO steel showed that they differ appreciably between the core and the surface (7 kg/mm^2 difference in the yield strength, for instance). Chemical analysis and differential dilatometry, on the other hand, gave similar results for both the core and surface. (P.C.H.)

14818 (EURAEC-1773) INFLUENCE OF NITROGEN IN IRON AND STEEL UNDER FAST NEUTRON IRRADIATION. Annual Report. (Societe Ricerche Impianti Nucleari, Saluggia (Italy). Centro Ricerche Nucleari). Nov. 1966. Contract 074-65-10-TEEI(RD). 77p. (EUR-3321). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States-Euratom Joint Research and Development Program.

Results are reported for studies on: properties of Fe alloys, including tensile, impact, and fracture tests; radiation effects on magnetic properties of Fe alloys and pure Fe; neutron spectrum influence on radiation damage in Fe; and mechanical properties of modified ASTM A212 steels, including transition temperature of the materials and a structure analysis in different heat treatment conditions. (P.C.H.)

14819 (GEAP-5410) LOW-CYCLE FATIGUE STRENGTH REDUCTION IN NOTCHED FLAT PLATES. Krempl, E. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jan. 1967. Contract AT(04-3)-189. 32p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

After a brief review of the design procedure in high-cycle fatigue an approach is outlined for the low-cycle fatigue region. A differentiation between a stress and a strain approach seems to be mandatory in evaluating the influence of stress raisers on low-cycle fatigue life. Good correlation was found when analytical elasto-plastic strain values were compared with strain gage measurements in the root of the notch of flat-plate specimens under monotonic loading. Low-cycle fatigue tests on edge-notched flat-plate specimens, of three standard piping materials, at room temperature, under pulsating tension loading, were analyzed under special consideration of crack initiation and crack propagation. Fatigue-strength-reduction factors were derived and compared with the proposed approach. (auth)

14820 (GMAD-3643-8) INVESTIGATION OF BIMETALLIC LIQUID METAL SYSTEMS. Final Report. (General Motors Corp., Indianapolis, Ind. Allison Div.). Sept. 30, 1966. Contract AT(30-1)-3643. 124p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An examination and analysis was made on material from bimetallic (AISI 316 SS and Nb-1%Zr) liquid metal (K) systems as a continuation of previous work to better define design limits for these materials in long-life system applications. The systems operated between 1200 and 1500°F for times up to 8000 hr. Results indicate that phase changes in the AISI 316 SS involve formation of complex carbides ($Cr_{23}C_6$) and chi phases. Stress rupture testing of loop-exposed specimens shows a decrease of about 65% in life at a given stress (or about 25% in stress value for a given life) after 3000 to 8000 hr of exposure. Exposing control specimens to 1500°F in air prior to stress rupture testing did not affect stress-rupture life. Exposure to liquid metal at 1350 and 1450°F caused a consistent, but not large, decrease in low-cycle fatigue life. Analyses of N_2 gradients in the stainless steel containment showed that although N_2 diffused into the loop through the high temperature AISI 316 SS, no area of outward diffusion of N_2 through the stainless steel was found. Detailed chemical and metallurgical analyses of a loop which operated for 8000 hr was used for kinetics analysis of N_2, C, and O_2 transport. Approximate diffusion coefficients were obtained for C and N_2 in AISI 316 SS. Diffusion coefficients for C in stainless steel were orders of magnitude greater than those in the refractory alloy. C transport from the high temperature portion of the loop was limited only by solid-state diffusion in the AISI 316 SS and not by surface reaction or liquid metal solubility. Qualitative examination of air-side surfaces indicated no catastrophic oxidation of stainless steel surfaces when surface temperatures did not exceed 1500°F. Ni fins became embrittled (probably due to O_2 diffusion) after 8000 hr of operation at 1350 to 1500°F. (auth)

14821 (HW-33726(Rev.)) AN INVESTIGATION OF THE PROPERTIES OF ROLLED URANIUM RELATED TO THE QUENCH AFTER BETA HEAT TREATING. Bement, A. L. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Dec. 13, 1954. Contract AT(45-1)-1350. 44p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Data are presented which show that quenching noticeably affects the dimensional change, hardness, orientation, and macrostructure of rolled, beta heat-treated U. The warping of slugs during in-pile operation might be traced to uneven quenching techniques. Finally, cooling curves for quenching U slugs in water show a marked difference in the quenching rate with the water temperature. (auth)

14822 (N-66-26246) AN EXPERIMENTAL INVESTIGATION OF THE RE-ENTRY BEHAVIOR OF METALS AND ALLOYS. Pinchok, R. N.; Bridges, J. M. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Dec. 31, 1964. 152p. (NASA-CR-75093; WANL-TNR-192). CFSTI $3.00 cy, $0.65 mn.

An investigation was made of the re-entry behavior of a series of metals and alloys currently envisioned as being important structural components in the NERVA reactor. The re-entry behavior of one-half inch models was examined in a plasma-jet facility. The materials studied were Al 6061-T6, Al alloy 2219-T852, Ti A 110-At, Stainless Steel 304-A, Inconel-X750, and Be. The ablation of Al, Al alloy, and Ti is determined entirely by the melting process. In the case of Ti and stainless steel, the presence of a thick, tenacious oxide coat on the samples surface inhibits ablation. However, on pre-oxidized stainless steel samples, where cracks and spalling of the oxide layer were evident the ablation process is accelerated. The ablation of Inconel-X and stainless steel at high heating rates is similar to that of Al, Al alloy, and Ti. (auth)

14823 (ORO-2570-10) SORPTION KINETICS AND MECHANICAL PROPERTIES OF DILUTE COLUMBIUM-HYDROGEN SOLUTIONS. Oakwood, Thomas Glenn; Daniels, Raymond D. (Oklahoma Univ. Research Inst., Norman). Feb. 1967. Contract AT(40-1)-2570. 124p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The sorption kinetics and mechanical properties of dilute Nb-H solutions were investigated. The sorption kinetics, measured by a thermal equilibrium technique, was found to be sensitive to surface condition and insensitive to grain size. The sorption rate was adequately described by a diffusion controlled reaction in the temperature range 600 to 750°C provided that the metal surface was abraded to remove effects of chemical etching. Below 600°C a surface step reaction apparently controls the sorption process, rather than bulk diffusion. H_2 was found to have little effect on the strength of Nb in the temperature range 77 to 300°K. The ductility of hydrogenated Nb, however, was found to be sensitive to H_2 concentration, temperature, and microstructure. At 300°K, an abrupt loss in ductility was observed at a critical H_2 concentration. A similar result was found at a lower H_2 concentration at 191°K, with the ductility loss being greater at the lower temperature. At 77°K, however, a gradual loss in ductility with increasing H_2 content was observed. Hydrogenated Nb was thus observed to undergo a ductile-

brittle-ductile transition as the temperature was lowered from 300 to 77°K. Crack formation appears to be due to a hydride precipitation in localized regions of high hydrogen concentration. H_2 diffusion to the microcracks from the surrounding regions is evidently responsible for crack propagation. H_2 apparently either adsorbs on the internal surfaces of a microcrack thereby lowering its surface energy, or diffuses to the tip of a crack resulting in a lower Nb atom bond strength. (P.C.H.)

14824 (SC-CR-66-2085) SPALLATION THRESHOLDS OF I-400 BERYLLIUM. Charest, J. A.; Warnica, R. L. (General Motors Corp., Santa Barbara, Calif. Defense Research Labs.). July 1966. Contract AT(29-1)-789. 22p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Incipient spall thresholds of I-400 Be were determined. Target loadings were obtained by planar impacts of I-400 Be discs against targets of the same material. Three submicrosecond target loadings were investigated and results show this alloy to have time-dependent incipient spalls. They were observed at impact velocities of about 550, 500, and 400 feet/sec for 0.2, 0.4 and 0.8 μ sec times of loading, respectively. (P.C.H.)

14825 (UCRL-16117) I. LOW TEMPERATURE HEAT CAPACITIES OF VANADIUM, NIOBIUM AND TANTALUM. II. LOW TEMPERATURE HEAT CAPACITY OF FERROMAGNETIC CHROMIC TRIBROMIDE. Shen, Yun Lung (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1965. Contract W-7405-eng-48. 96p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. Thesis.

Experimental studies were made on the heat capacities of V, Nb, and Ta from 0.3 to 25°K in both normal and superconducting states. The anomalous superconducting-state heat capacities at low temperatures are ascribed to the existence of a second energy gap. These measurements constitute the first experimental evidence for the theoretically-predicted second energy in superconducting transition metals. The effect of purity on the superconducting electronic heat capacity was studied, and compared with the electron mean free path via measurements of residual resistances. It was concluded that the lattice heat capacities for these metals are likely to be the same in both normal and superconducting states. Both V and Nb have the same limiting normal-state lattice heat capacities as that determined from the elastic constants. The heat capacity of ferromagnetic $CrBr_3$ was measured from 0.3 to 25°K in 0, 20.4, and 27 kG magnetic fields. Use was made of three parameters, J_t, J_1, and H_A, determined from the magnetic properties of $CrBr_3$ to calculate the magnetic heat capacity from the spin-wave theory. (auth)

14826 (WAPD-T-1699) FATIGUE NOTCH SENSITIVITY OF ZIRCALOY WELD METAL. O'Donnell, W. J. (Bettis Atomic Power Lab., Pittsburgh, Pa.). May 1964. Contract AT-11-1-GEN-14. 23p. (CONF-654-101). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From American Nuclear Society Meeting, San Francisco, Nov. 1964.

The results of notched fatigue tests on unirradiated Zircaloy weld metal at 600°F were analyzed using the δ-theory. This material was found to be considerably more notch sensitive than Zircaloy wrought material. This conclusion was verified by tests on specimens containing weld cracks. Theoretical "worst case" fatigue notch factors were derived for subassembly side wall design accounting for the high notch sensitivity of the material. (auth)

14827 MAGNETIC PROPERTIES OF SOME RARE-EARTH ALLOYS AT HIGH PRESSURES. McWhan, D. B.; Stevens, A. L. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 154: 438-45(Feb. 10, 1967).

The Néel and Curie temperatures of some alloys of the heavy rare earth metals with each other and with Y have been measured as functions of pressure up to ~85 kbar. The initial slopes (dT/dP) are approximately proportional to the average de Gennes function $[\Sigma_i c_i(g_i - 1)^2 J_i(J_i + 1)]$. In the molecular field approximation with a first-order correction for the anisotropy energy, the change in the exchange interaction with lattice parameter is given by k^{-1} dJ(Q)/da = (42 ± 6)°K/Å. It is suggested that this is caused mainly by a change in the generalized conduction-electron susceptibility with pressure. A polymorphic transition from a hexagonal-close-packed structure to a Sm-type structure is found with increasing pressure in many of these alloys, and the Sm-type phase has two ordering temperatures. The higher ordering temperature of the Sm-type phase is 10% lower than that of the hcp phase, and the two ordering temperatures in the Sm-type phase differ by 17%. (auth)

14828 ANOMALOUS THERMAL EXPANSION AND MAGNETOSTRICTION OF HOLMIUM SINGLE CRYSTALS. Rhyne, J. J. (Naval Ordnance Lab., White Oak, Silver Spring, Md.); Legvold, S.; Rodine, E. T. Contract W-7405-eng-42. Phys. Rev., 154: 266-9(Feb. 10, 1967). (IS-1383).

The a-, b-, and c-axis linear strains of single-crystal Ho have been measured from room temperature to 4°K in zero field and in applied fields up to 30 kOe. Pronounced bumps appeared in the thermal-expansion coefficient at the magnetic ordering temperatures of 132 and 20°K. The exchange magnetostriction contribution to the total c-axis strain was isolated and compared to the predictions of the molecular-field theory applied to spiral antiferromagnets. Strain data taken with an applied field show the effects of "fanning" of the moment about the applied-field direction and of the onset of basal-plane anisotropy below 75°K. The dependence of the basal-plane magnetostriction on field angle was measured in the temperature range of magnetic order. Saturation values of the second-order magnetostriction constant were compared with the results of single-ion magnetoelastic theory. A value of 2.5×10^{-3} at T = 0°K was calculated. (auth)

14829 MATERIALS IN AN ATLAS-AGENA SHROUD. Langston, Merritt E. (Lewis Research Center, Cleveland). Metal Progr., 91: No. 2, 125-8; 30(Feb. 1967).

Be and alloys of Al, Mg, and Ti were tested for performance as shroud materials for the Atlas-Agena launch vehicle. Properties of prime importance in their selection were weight, tensile properties, and thermal resistance up to 1510°F. (P.C.S.)

14830 EMISSIVITY AND ELECTRICAL RESISTIVITY OF TANTALUM AT HIGH TEMPERATURES. Hoerz, Gerhard (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk., 57: 871-3(Dec. 1966). (In German).

Investigations showed that the resistivity ρ of degassed Ta was 12.8 $\mu\Omega \cdot$cm at 7°C and increased almost linearly from 54.6 to 102.9 $\mu\Omega \cdot$cm between 1000 and 2500°C having a temperature dependence of $d\rho/dT = 3.2 \times 10^{-2}$ $\mu\Omega \cdot$cm/°C. The total emissivity increased linearly from 0.15 at 1000 to 0.35 at 2500°C. The resulting values of the emissivity and resistivity of Ta are compared with the respective values of V and Nb. The emissivity and the resistivity, as well as their temperature dependence increase in the order Nb, Ta, and V. (auth)

14831 INFLUENCE OF IMPURITIES ON THE DISCONTINUOUS FLOW OF HIGH-MELTING METALS. Pink, E. (Metallwerk Plansee AG, Reutte/Tyrol, Austria). Planseeber. Pulvermet., 14: 165-77(Dec. 1966). (In German).

Tensile tests were carried out with recrystallized Ta samples. At certain elevated temperatures the stress-strain curves showed pronounced repeated yielding effects, caused by interactions of migrating dislocation lines with following Cottrell clouds of interstitial impurities, dragged along by diffusion. Using equations established by Friedel repeated yielding at a certain temperature may be correlated to one certain element. Thus O_2 acted at 300 to 400°C, Ca and N_2 at 600 to 900°C. H_2, according to calculation, should have acted at 100 to 200°C, but was ineffective because of its low concentration. With Mo and W serrated curves were not observed, as there were not sufficient amounts of solute atoms present due to low solubility for interstitials. Discontinuous yielding as exhibited with W at approximately 1300°C, might be attributed to substitutional atoms. (auth)

14832 MATERIALS TECHNOLOGY PRESENTLY AVAILABLE FOR ADVANCED RANKINE SYSTEMS. Moss, Thomas A. (Lewis Research Center, Cleveland). Nucl. Appl., 3: 71-81 (Feb. 1967).

Many different classes of materials are required in the development of advanced Rankine systems. These materials include nuclear fuels in the reactor, refractory metal alloys for alkali metal containment, electrical materials for the alternator, and stainless steel for the radiator. The ceramics UC and UO_2 are presently being considered as reactor fuels for this system. Of the numerous refractory metal alloys available, the tubing alloys FS-85 (Nb-10W-28 Ta-1Zr), T-111 (Ta-8W-2Hf), and T-222 (Ta-10.4W-2.4Hf-0.01C), have survived the welding, thermal aging, and mechanical property screening tests. Based on long-time creep data, the alloys TZC (Mo-1.25Ti-0.15Zr-0.12C), TZM (Mo-0.5Ti-0.08Zr), and Cb-132M (Nb-20Ta-15W-5Mo-2Zr-0.13C) appear the best for turbine rotor applications. Long-time property data are becoming available for electrical materials for applications up to 1000°F, and new electrical materials are being developed for higher temperatures. Cermets with properties suitable for applications as alkali-metal-lubricated bearing materials are available. Stainless steel operating below 1400°F will probably be used in radiators for this system. (auth)

14833 BRAZED GRAPHITE-METAL COMPOSITES FOR SPACE RADIATORS. del Grosso, A. (Space Systems Center, Huntington Beach, Calif.). Nucl. Appl., 3: 94-101(Feb. 1967).

Brazing techniques for joining dissimilar materials considered for tube-to-armor joints of high-temperature graphite space radiators were investigated. The combinations tested consisted of Nb-1Zr and type-316 stainless-steel alloys, each brazed with

developmental alloys to Graphite-G and an expanded form of pyrolytic graphite. Stability test results are reported for specimens brazed and aged 500 hr at 1350°F (734°C) or thermally cycled 500 times between 350°F (177°C) and 1350°F under a pressure of 10^{-5} torr (max). Brazing and thermal stability tests indicated that compatible braze bonds can be made between the graphites and potential tube materials. (auth)

14834 BRITTLE BEHAVIOR IN EXTRUDED BERYLLIUM TUBES. Sumner, G. (United Kingdom Atomic Energy Authority, Springfields, Eng.). Int. J. Fracture Mech., 2: 448-59(June 1966).

During the development of a Be-clad UO_2 fuel element an unusual form of extremely brittle fracture of the Be can was found if tensile strains developed in the can by differential thermal contraction onto the UO_2 fuel at temperatures of 300°C or below. The highly textured Be can produced by a double extrusion route failed by the audible propagation of a helical crack along the element; the helix angle was about 25°C in all cases and sometimes two helices of opposite sense caused the element to break into several pieces. Calculations showed that the fracture occurred after only 0.15% plastic strain, considerably less than the tensile ductility of an extruded rod at the same temperature (10% is typical). The characteristic spiral form of fracture was caused by cleavage failure of the highly textured tube along $(11\bar{2}0)$ planes under biaxial stress generated by the contraction of the can onto the pellets, but the crystallography of the fracture did not reveal cause of the unexpectedly low plasticity. Mechanical testing of the tubes revealed circumferential ductilities of about 1%, in agreement with values expected from the high degree of texture of the tube; axial ductilities were anomalously very low, about 0.2%. Less textured materials gave longitudinal ductilities of several percent, expected from the texture. Thin filaments cut from the walls of double extruded material gave much greater elongations than the whole tube, showing that the material was not inherently brittle and tests on filaments of varying arc widths suggested that progressively increasing the width of curved specimens were accompanied by decreasing ductility. Evidence is presented that the brittleness is caused by premature failure following the action of a secondary deformation process activated by transverse loop stress arising from the plastic anisotropy of the material and the tube curvature. This process may involve twinning, known to lead to non-ductile failure. (BBB)

14835 STEELS IN NUCLEAR ENGINEERING. Rajakovics, G. E. Chem. Process Eng., 48: 71-3; 82(Feb. 1967).

The requirements of high-grade steels for nuclear plants led to an improvement in quality of conventional steels. Corrosion problems with a diverse range of chemical media had to be solved to a very stringent safety standard, while maintaining the strength characteristics of normal steels. Fabrication of reactor pressure vessels, which are usually large, led to better design methods; it is envisaged that an ultimate yield strength of 70 kg/mm^2 will be reached. Special alloys incorporating boron and aluminum, which were developed for their nuclear properties, may become industrial alloys of the future. (auth)

14836 INVESTIGATIONS OF SURFACES OF THE BINARY SYSTEM Ta–Fe BY MEANS OF AN EMISSION ELECTRON MICROSCOPE. Wetzig, K. (Technische Univ., Dresden). Phys. Status Solidi, 19: K71-3(Feb. 1, 1967).

Surface investigations of polycrystals with the matrix $TaFe_2$ were carried out in a secondary electron emission microscope. The samples were prepared by melting at the stoichiometric ratio of $TaFe_2$. The phase of the samples is discussed. (M.O.W.)

14837 MAKING SATELLITE STRUCTURES FROM BERYLLIUM–LOCKALLOY. Van Hamersveld, John A.; Svendsen, Thomas S.; Hayes, Walter C. (Hughes Aircraft Co., El Segundo, Calif.). Metal Progr., 91: No. 2, 91-5(Feb. 1967).

Results of the 1965 program to evaluate Beryllium–Lockalloy (62Be–38Al) as a structural material for space vehicles are reported. The alloy was readily fabricated by conventional metallurgical techniques. It was found suitable for compressively loaded applications where moderate formability (10 to 12T bend radii) and light weight are required. Properties of the alloy are compared with Al, Be, Mg, Mg–Li, and Ti–6Al–4V. (P.C.S.)

14838 VYSOKOTEMPERATURNYE NEORGANICHESKIE SOEDINENIYA. (High-Temperature Inorganic Compounds). Samsonov, G. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1965. 476p.

Separate abstracts were prepared for 24 of the 57 chapters of the book. Abstracts of two chapters appeared previously in NSA as abstracts 19: 23041 and 20: 19249. Other chapters discuss materials outside the scope of NSA. (A.G.W.)

For abstracts of individual chapters see: 14796, 14812, 14813, 14839–14842, 14856, 14875–14878, 14896–14900, 14906–14908, 14914, and 15002–15004.

14839 THERMAL EXPANSION OF SOLID SOLUTIONS OF THE HIGH MELTING METALS OF IV, V, AND VI GROUPS OF THE PERIODIC SYSTEM. Pridantseva, K. S.; Solov'eva, N. A. pp 41-7 of Vysokotemperaturnye Neorganicheskie Soedineniya. Samsonov, G. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1965. (In Russian).

The effect of temperature on the thermal expansion coefficient of binary alloys involving Mo, Cr, Nb, V, Zr, Ti, Hf, and Fe in various ratios was studied in the 20 to 1000°C range. No maxima of minima were observed on the curves relating to alloy composition and thermal expansion coefficient, whether or not the alloys exhibited ferromagnetic anomaly or formed α phases. In the entire temperature range, a monotonic relationship was found between alloy composition and thermal expansion coefficient. The dependence of the thermal expansion coefficient upon alloy composition is shown in figures for various alloys in various temperature ranges. (ATD)

14840 INVESTIGATION OF TEMPERATURE DEPENDENCE OF THERMAL AND ELECTRIC CONDUCTIVITY OF TANTALUM AND NIOBIUM. Pozdnyak, N. Z.; Akhmetzyanov, K. G. (All-Union Correspondence Polytechnic Inst., USSR). pp 48-51 of Vysokotemperaturnye Neorganicheskie Soedineniya. Samsonov, G. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1965. (In Russian).

The thermal and electrical conductivities of Ta and Nb were examined in the 273 to 1573°K range. The metal samples were 4 mm in diameter and 10 mm in length. The Ta samples contained 5.0% Nb and the Nb samples contained 0.5% Ta. Both samples contained small amounts of C, Fe, Ti, Si, W, and Mo. The thermal conductivity of Ta and Nb was found to increase with temperature; below 400°K the values were 10% higher than the corresponding values reported in the literature. The electrical conductivity of Ta and Nb declines with increasing temperature; the values found in this work agree well with those reported in the literature. It was found that the thermal conductivity of Ta and Nb depends upon their electron conductivity and upon conductivity of their crystal lattices. Data on thermal conductivity (λ), electrical conductivity (χ) and the λ/χ ratio for Ta and Nb are given in a table. (ATD)

14841 SOME PHYSICAL PROPERTIES OF THE COMPOUNDS OF NIOBIUM WITH TRANSITION ELEMENTS ($NbCr_2$, $NbCo_2$, $NbFe_2$). Elyutin, O. P.; Bokshitskii, I. Ya.; Rogova, I. V. (Inst. of Steel and Alloys, USSR). pp 52-4 of Vysokotemperaturnye Neorganicheskie Soedineniya. Samsonov, G. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1965. (In Russian).

The type of crystal lattice, the temperature dependences of normal resistivity modulus and electrical conductivity, the specific electrical resistivity, the thermal coefficient of electrical conductivity, the paramagnetic susceptibility, the absolute thermoelectric force at 20 to 100°C, the coefficient of thermal expansion at 20 to 900°C, the normal modulus of elasticity, the temperature dependence of elasticity modulus, and the hardness were determined for $NbCr_2$, $NbCo_2$, and $NbFe_2$ samples. The samples were prepared by soaking liquid-phase metals into quartz ampoules 3 mm in diameter. They were subsequently homogenized by holding for 4 hours at 1000°C. The temperature dependence of the normal modulus of elasticity and the electrical resistivity of $NbCr_2$, $NbCo_2$, and $NbFe_2$ are graphed. Data on physical properties of $NbCr_2$, $NbCo_2$, and $NbFe_2$ are presented in tabular form. (ATD)

14842 EFFECTS OF ALLOYING ON THE CHARACTER OF THE INTERATOMIC REACTIONS IN NIOBIUM SOLID SOLUTIONS. Tarasov, N. D.; Ul'yanov, R. A.; Mikhailov, Ya. D. (Inst. of Physics and Tech., Academy of Sciences, USSR). pp 55-62 of Vysokotemperaturnye Neorganicheskie Soedineniya. Samsonov, G. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1965. (In Russian).

Alloying components of Nb solid solutions effectively increase the strength of the material and reduce the ductility at room temperature. The most effective additions are Cr, Re, Zr, and Ti. The coefficient of linear expansion was increased with increased concentration of Ta, W, Re, Mo, Ir, and Zr in Nb solid solutions, while the modulus of elasticity and characteristic temperature increased because of the increased force of interatomic interactions. (R.V.J.)

14843 PROCEEDINGS OF THE FIRST INTERNATIONAL CONFERENCE ON FRACTURE HELD IN SENDAI, JAPAN, SEPTEMBER 12–17, 1965. VOLUME I. Yokobori, T.; Kawasaki, T.; Swedlow, J. L. (eds.). Japan, Japanese Society for Strength and Fracture of Materials, 1966. 585p. (CONF-650949–(Vol.1)).

Mathematical, physical, and continuum mechanical theories and their application to fracture are covered in 29 papers, which were

presented at the conference. For the remaining papers of the 126 produced at the conference see Volumes II and III. (P.C.S.)

14844 PROCEEDINGS OF THE FIRST INTERNATIONAL CONFERENCE ON FRACTURE HELD IN SENDAI, JAPAN, SEPTEMBER 12–17, 1965. VOLUME 2. Yokobori, T.; Kawasaki, T.; Swedlow, J. L. (eds.). Japan, Japanese Society for Strength and Fracture of Materials, 1966. 784p. (CONF-650949–(Vol.2)).

Thirty-seven papers are given on atomistic, microstructural, and macroscopic mechanics as related to fracture of metals and alloys. Ten additional papers are included on strength and fracture of non-metallic materials. A separate abstract was prepared for one paper. For remaining papers of the 126 produced by the conference see Volumes I and III. (P.C.S.)

For an abstract of the individual paper see: 14845.

14845 MICRO-PLASTICITY OF URANIUM DIOXIDE AT ROOM TEMPERATURE. Igata, N. (Tokyo Univ.); Hasiguti, R. R.; Domoto, K. pp 883-98 of Proceedings of the First International Conference on Fracture. Vol. 2. Yokobori, T.; Kawasaki, T.; Swedlow, J. L. (eds.). Japan, Japanese Society for Strength and Fracture of Materials, 1966.

Micro-plastic deformation was observed in the pre-fracture process of UO_2 at room temperature by means of strain rate dependence of flow stresses, ultrasonic measurements, and etch pit techniques, using fused single crystals and sintered pellets. The difference between the ultrasonic attenuation of compressed state and that of annealed state showed the maximum as a function of frequency. This was interpreted to be the resonance damping of dislocations introduced by plastic compression. The frictional force of dislocation movement was obtained from the decrement of over-damped region. The value was 1 to 3×10^{-2} in sintered pellets and $\sim 1 \times 10^{-3}$ in fused single crystals. (auth)

14846 PROCEEDINGS OF THE FIRST INTERNATIONAL CONFERENCE ON FRACTURE HELD IN SENDAI, JAPAN, SEPTEMBER 12–17, 1965. VOLUME 3. Yokobori, T.; Kawasaki, T.; Swedlow, J. L. (eds.). Japan, Japanese Society for Strength and Fracture of Materials, 1966. 821p. (CONF-650949–(Vol.3)).

Fifty-four papers are presented with 10 relating to strength and fracture of nonmetallic materials; 26 on fatigue and fracture with emphasis on macroscopic behavior; and 16 on environmental effects, high pressure, high temperature, and high strain rates. Separate abstracts were prepared for 3 papers. For the remaining papers of the 126 produced at the conference see Volumes I and II. (P.C.S.)

For abstracts of individual papers see: 14847, 14866, and 14867.

14847 EFFECT OF CAPILLARY ACTION ON FRACTURE DUE TO LIQUID METAL EMBRITTLEMENT. Perrone, N.; Liebowitz, H. (Office of Naval Research, Washington, D. C.). pp 2065-72 of Proceedings of the First International Conference on Fracture. Vol. 3. Yokobori, T.; Kawasaki, T.; Swedlow, J. L. (eds.). Japan, Japanese Society for Strength and Fracture of Materials, 1966.

The influence of capillary action on fracture due to the liquid-metal embrittlement of solid metals was studied. The conjecture that capillary action enhances the penetration of liquid metals into solids is discussed. It is suggested that high pressures may not arise in the process of liquid-metal embrittlement. A Poiseuille type of flow model is postulated and a prediction made therefrom of crack-length growth with time. Some verification was obtained with experimental observations. (auth)

14848 SYMPOSIUM ON HEAT-TREATED STEELS FOR ELEVATED TEMPERATURE SERVICE, SEPTEMBER 19–20, 1966, NEW ORLEANS, LOUISIANA, HELD AS PART OF THE 21ST ANNUAL PETROLEUM-MECHANICAL ENGINEERING CONFERENCE. Semchyshen, M. (ed.). New York, American Society of Mechanical Engineers, 1966. 182p. (CONF-660943).

The conference proceedings include 10 papers, which deal with the behavior of various type steels at elevated temperatures. Various steel treatment procedures are evaluated for their improvement of steel properties for high-temperature uses. The property evaluation is based on the possible use of the steels in the construction of pressure vessels in the petrochemical and nuclear fields. (B.L.M.)

14849 INVESTIGATION OF THE EFFECT OF OXYGEN ON THE TENSILE DEFORMATION OF ZIRCONIUM. Baldwin, David Hale. Gainesville, Fla., Univ. of Florida, 1966. 118p. Thesis.

Some effects of interstitial O atoms on the plastic deformation of polycrystalline Zr were determined. Zr–O solid solutions were formed by diffusion of O_2 into pre-machined high-purity Zr tensile specimens. Alloys containing up to 4.2 at. % oxygen were studied. Differential strain rate tests were conducted at several temperatures in the range 77° to 700°K. Oxygen strengthened Zr markedly at low temperatures; Zr–O alloys exhibited tensile strengths as high as 120,000 psi. The greatest strengthening effect was observed at low temperatures and it was accompanied by a loss of ductility. Alloys that were brittle at low temperatures became ductile at room temperature (300°K) or higher. Microstructural observations showed that O_2 inhibited twinning in Zr deformed at low temperatures. At elevated temperatures twinning occurred readily. However, in the alloys containing the greater amounts of O_2, twins were identified only on $\{10\bar{1}2\}$ planes. At all temperatures, oxygen promoted cross-slip out of the $\{10\bar{1}0\}$ slip planes usually active in pure Zr. The cross-slip planes were tentatively identified as $\{10\bar{1}1\}$ pyramidal planes. A tendency of O_2 to cause clustering of slip lines was also observed. (TSS)

Structure and Phase Studies

14850 (COO–1417-2) EXPERIMENTAL STUDY OF THE SURFACE STRUCTURE AND ELECTRONIC PROPERTIES OF SINGLE CRYSTAL MOLYBDENUM AND TUNGSTEN RIBBONS. Progress Report, November 1, 1965–August 1, 1966. Morgan, Donald R.; Blass, William E. (Saint Mary's Coll., Winona, Minn.). Aug. 1, 1966. Contract AT(11-1)-1417. 19p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Improved techniques for preparation of metallographic specimens indicate that Mo single crystals can be produced which show highly ordered surfaces after heating to 2000°K at pressures below 10^{-8} torr, as well as crystals with varying degrees of surface disorder. Low energy electron diffraction patterns for a Mo (100) surface were obtained. With improved equipment, measurements will be made of thermionic emissions of Mo and W single crystals. (P.G.C.)

14851 (DRI–2369) STUDIES OF THE EFFECT OF INTERSTITIAL ADDITION ON THE PHASE EQUILIBRIA OF THE NIOBIUM-RICH REGION OF THE NIOBIUM–TUNGSTEN–HAFNIUM AND NIOBIUM–TUNGSTEN–ZIRCONIUM ALLOY SYSTEMS. Quarterly Progress Report No. 9. Yamamoto, Albert S. (Denver Research Inst., Colo.). Dec. 1966. Contract AT(11-1)-1092. 11p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Data on phases and microhardness of a number of Hf–Nb–W–Zr alloys containing interstitial C or O_2 are reported. (P.G.C.)

14852 (EURAEC–1711) AUSTENITIZATION OF WEL-MONIX STEEL. Study No. 1018. (Chantiers de l'Atlantique Saint-Nazaire (France)). June 15, 1966. Contract 054-61-12-RDF. 8p. (EUR–2893). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Results of a study of re-austenization of Wel-Monix steel after heating to 1250°C are shown in photomicrographs. (P.G.C.)

14853 (ORNL–4066) SEMIAUTOMATIC PREPARATION OF SPECIMENS FOR TRANSMISSION ELECTRON MICROSCOPY. DuBose, C. K. H.; Stiegler, J. O. (Oak Ridge National Lab., Tenn.). Feb. 1967. Contract W-7405-eng-26. 35p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A rapid expansion in the use of transmission electron microscopy led to the development of new equipment designed to produce specimens of a variety of materials, often after neutron irradiation, in a quick and reliable manner. Specimens are cut, in a hot cell if necessary, to a thickness of about 20 mils and a maximum diameter of $\frac{1}{8}$ in. These are first "dimpled" on both sides by an electrolytic jet technique to reduce the thickness of the center of the specimen to about 2 mils. The shape of the dimple bottom is controlled by varying the current density; and under appropriate conditions large, flat-bottomed dimples can be formed. Final polishing is accomplished in a standard electrolytic polishing cell in which breakthrough in the dimpled region is detected by an extremely sensitive photocell device. Incident light is piped to the specimen and the light transmitted through the hole is delivered to the photocell by a fiber-optics system. This system provides a small, intense light beam and also eliminates interference from thermal fluctuations of the polishing solution and radiation effects on the photocell. Activation of the photocell stops the polishing action in the final step. With this technique, extremely small holes can be detected, which usually are surrounded by reasonably large areas transparent to 100 kV electrons. Full details on design of the equipment and operations of the techniques are included. (auth)

14854 CRYSTAL STRUCTURE OF Zr_5Si_4. Pfeifer, Hans-Ulrich; Schubert, Konrad (Max-Planck-Institut fuer Metallfor-

schung, Stuttgart). Z. Metallk., 57: 884-8(Dec. 1966). (In German).

The structure of Zr_5Si_4 was determined and it was confirmed that Hf_5Si_4 and Zr_5Ge_4 are isostructural. The structure of Zr_5Si_4 was found to be similar to that of ZrSi(h) and was considered as a special variety of the CrB-structure. (auth)

14855 STUDY ON THE RELATIONSHIP BETWEEN THE STRUCTURE OF ZIRCALOY 2 AND ITS RESISTANCE TO CORROSION BY STEAM UNDER PRESSURE AT 400 DEG C. Lelong, P.; Perez, M.; Herenguel, J. Energ. Nucl. (Paris), 8: 403-10 (Sept.-Oct. 1966). (In French).

The main structural developments of Zircaloy 2 were studied by dilatometry and micrography. The structure types can be classified after the temperature of the last heating stage: ex-β, ex$(\alpha + \beta)_2$, ex$(\alpha + \beta)_1$, ex-$(\alpha + \beta)$ + x, α. The influence of the cooling state, the metallurgical transformation conditions, and the stability of the structures were also defined. The behavior under pressurized steam depends almost solely on the speed of the last transformation $\beta \rightarrow \alpha$. It can be that this influence results from the distribution of the phases which separate themselves at the end of this transformation, and from modifications in the strength of the final α solid solution. (auth)

14856 PHASE CONVERSION OF HIGH-MELTING-POINT METALS AND COMPOUNDS. Nedumov, N. A.; Grigorovich, V. G. (Baikov Inst. of Metallurgy, USSR). pp 25-36 of Vysokotemperaturnye Neorganicheskie Soedineniya. Samsonov, G. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1965. (In Russian).

A thermographic method was developed for thermal analysis at temperatures up to 2800°C. Thermograms of various transition metals were constructed and analyzed. Data on thermal effects in melting of transition metals are in agreement with published data. Thermal effects of phase transformation in Ni_3, Al, Ni_3, Nb, Ni_3Ta, and $NbCr_2$ and $ZrCr_2$ were investigated and a new transformation of Ni_3Ta at 1200 to 1210°C was found. (R.V.J.)

Radiation Effects

Refer also to abstracts 14798, 14885, and 14912.

14857 (AECL-2350) TRANSPORT OF OXYGEN IN OXIDE FILMS ON ZIRCONIUM DETERMINED BY THE NUCLEAR REACTION $^{17}O(^3He,\alpha)^{16}O$. Cox, B.; Roy, C. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Oct. 1965. 30p. (CONF-651017-4). Dep. AECL $1.00

From Electrochemical Society Meeting, Buffalo.

By irradiation of Zr specimens oxidized wholly or partially in 50% ^{17}O with ^3He ions and by measuring the α-particles emitted from the $^{17}O(^3He,\alpha)^{16}O$ reaction as a function of energy, it was possible to determine the concentration of ^{17}O as a function of depth in the Zr and its oxide. Experiments in which oxide films grown in ^{16}O were subsequently heated in 50% ^{17}O at 400 or 500°C and those in which Zr layers were evaporated onto the surface of films formed in ^{16}O, oxidized briefly in 50% ^{17}O at 400 or 500°C, and then were heated in vacuum at the same temperature, permitted a study of O_2 transport in growing oxide films directly, without invoking any assumptions about the mechanism of oxidation. Results showed that the concentration of ^{17}O close to the surface never attains more than a small fraction of the saturation value, and that the logarithm of the concentration at any point below the surface decreased approximately linearly with increasing depth; however, the results also gave a straight line on a probability plot. It was concluded that the observed transport of O_2 may be by a line diffusion process, (via crystallite boundaries in the oxide) with lattice diffusion so slow that it is not observed at 500°C or below by this technique; alternatively the transport of O_2 may be controlled by some barrier close to the surface of the oxide, with the observed distribution being the result of lattice diffusion. It has not been possible, from the evidence obtained, to distinguish between the two possibilities. Diffusion coefficients in Zr have been determined from the distribution of O_2 in the metal, below the oxide film, on samples which had porous oxides (permitting easy access of oxygen to the metal oxide interface). The results suggest that a line diffusion process, where transport is along grain boundaries or dislocations, controls O_2 penetration into the metal at temperatures below 600°C. (auth)

14858 (GA-7463) A RESEARCH PROGRAM ON THE EFFECT OF SUBSTRUCTURE ON THE IRRADIATION STABILITY OF ASTM A302 GRADE B STEEL. Quarterly Progress Report No. 6. Trozera, T. A.; Flynn, P. W. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Oct. 18, 1966. Contract AT(04-3)-167. 13p. (EURAEC-1741). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States-Euratom Joint Research and Development Program.

The first irradiation capsule was inserted in the Low Intensity Test Reactor (LITR) at Oak Ridge National Laboratory and the second capsule is ready for insertion. Samples of cold-worked and heat-treated A302-B steel and warm-worked A302-B steel were thinned for electron-microscopic examination. (auth)

14859 (N-66-39926) EFFECT OF NUCLEAR RADIATION ON MATERIALS AT CRYOGENIC TEMPERATURES. Quarterly Report No. 4, April 21-July 21, 1966. Schwanbeck, C. A. (Lockheed-Georgia Co., Marietta). Aug. 1966. Contract NAS3-7985. 95p. (NASA-CR-72056; LAC-ER-8673). CFSTI $3.00 cy, $0.65 mn.

Recovery for the cryogenic depression of the F_{ty}/F_{tu} ratio in Al 1099-H14 (unirradiated) was observed to be an essentially linear function of irradiation level. After 3×10^{17} n/cm^2 (E > 0.5 MeV), this parameter at 30°R is over 70% of its initial room temperature value, indicating a similarity between irradiation effect and work hardening. There was no significant difference between the mechanical properties of Al 1099 after irradiation to 10^{17} n/cm^2 (E > 0.5 MeV) at 30°R followed by annealing and testing at several higher temperatures, and the same properties from specimens, both irradiated to 10^{17} n/cm^2 (E > 0.5 MeV) and tested at the higher temperatures. However, significant variation was observed between the residual irradiation effects after annealing when tested at the annealing temperature and when re-cooled to the irradiation temperature prior to test. Increases in strength functions, accompanied by moderate reductions in ductility were observed in the three Ti alloys for which testing was complete. There was no evidence of saturation at 10^{18} n/cm^2 (E = 0.5 MeV). (auth)

14860 (WCAP-3677-1) FRACTURE MECHANICS EVALUATION OF REACTOR VESSEL STEELS. Technical Progress Report for the Period Ending September 30, 1966. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Oct. 1966. Contract AT(30-1)-3677. 21p. (EURAEC-1720). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States-Euratom Joint Research and Development Program.

Experimental tests to be made on a group of reactor vessel steels to investigate the fracture mechanics technique to these materials in both the unirradiated and irradiated conditions are described. Materials to be investigated will include base metal, weld, and heat affected zone samples from two different heats of a Ni modified, Mn-Mo steel and a European forging grade material. (P.C.H.)

14861 EMBRITTLEMENT OF NICKEL BASE ALLOYS CONTAINING ALUMINIUM AND CHROMIUM AS USED FOR THERMOCOUPLE MATERIALS. Thomas, M. W.; Meredith, K. E. G. (Berkeley Nuclear Labs., Eng.). Brit. Corros. J., 1: 199-204 (Mar. 1966).

Embrittlement failure of base metal thermocouples of the mineral-insulated type in nuclear reactors was examined, particularly on the basis of sulfur attack, carbide formation, and oxidation. Failures of thermocouples in reactors was shown to be due to embrittlement of the Ni-Al conductors. The basic metallurgical mechanisms affecting embrittlement of the conductors, and their relation to emf drift, were examined. Selective oxidation was considered to play the major role in embrittlement, and a model for selective oxidation is presented with suggestions for remedial action. Initially, oxidation tends to occur preferentially at the grain boundaries, under all conditions of oxidizing atmosphere. If a protective film is formed on the surface, further preferential attack at the grain boundaries is suppressed. This will occur when O_2 is freely available. If the surface oxide film remains thin and nonprotective, preferential grain boundary attack can continue unhindered. This condition is likely to exist where the O_2 supply is limited. A limited supply of O_2 will also enhance selective oxidation of the alloying element, thus contributing to emf drift. (BBB)

14862 INTERSTITIAL DISLOCATION LOOPS IN NEUTRON-IRRADIATED COPPER. McIntyre, K. G. (Cambridge Univ., Eng.). Phil. Mag., 15: 205-8(Jan. 1967).

Transmission electron microscopy was used to study the small dislocation loops found in neutron-irradiated Cu. Stereomicrographs were used to determine the positions of a number of loops relative to the bottom surface of the microscopic foil. Inspection of the black-white contrast due to these loops showed that they were interstitial in nature. (auth)

14863 EFFECT OF IRRADIATION TEMPERATURE ON THE RESISTIVITY RECOVERY OF COPPER. Bauer, W. (Atomics International, Canoga Park, Calif.); Sosin, A. Contract AT(11-1)-Gen-8. Phys. Lett., 24A: 193-4(Feb. 13, 1967).

Copper samples, irradiated to equal resistivity increments at 70°K or at 10°K followed by a 70°K warming, show closely

identical annealing in stages II and III; thus ruling out dimer formation as a significant consequence of interstitial migration in stage I. (auth)

14864 CONVERSION-TWO-INTERSTITIAL MODEL FOR RADIATION DAMAGE IN fcc METALS. Bauer, W.; Seeger, A.; Sosin, A. (Atomics International, Canoga Park, Calif.). Contract AT(11-1)-Gen-8. Phys. Lett., 24A: 195-6(Feb. 13, 1967).

The production and recovery of defects in electron irradiated fcc metals is best accounted for by a two-interstitial model in which practically all stage III interstitials (dumbbells) are formed by conversion of stage I interstitials (crowdions). (auth)

14865 A KINETIC APPROACH TO INTERSTITIAL CLUSTERING IN NEUTRON-IRRADIATED METALS. Damask, A. C. (Brookhaven National Lab., Upton, N. Y. City Univ. of New York, Flushing); Dienes, G. J. Contract AT(30-2)-Gen-16. Phil. Mag., 15: 199-204(Jan. 1967). (BNL-10440).

An approximate kinetic description was developed for interstitial clustering in the presence of impurities, or other nucleating faults, under the assumption that equilibrium among the clusters prevails and that the vacancies resulting from neutron damage are primarily in clusters rather than randomly distributed. (auth)

14866 VARIATIONS IN THE EMBRITTLEMENT OF IRRADIATED PRESSURE VESSEL STEELS. Wessel, E. T. (Westinghouse Electric Corp., Pittsburgh). pp 1971-86 of Proceedings of the First International Conference on Fracture. Vol. 3. Yokobori, T.; Kawasaki, T.; Swedlow, J. L. (eds.). Japan, Japanese Society for Strength and Fracture of Materials, 1966.

The basic aspects of the deformation and fracture characteristics of several heats of ASTM A302B steel were investigated in terms of the Petch parameters. Both irradiation-sensitive and -insensitive conditions were represented. In the irradiated condition the friction stress, σ_i, increased with increased neutron exposure for all heats of steel. However, the sensitive heats exhibited a much greater increase in σ_i than did the insensitive heats. The grain boundary resistance, k_y, decreased with increased exposure, particularly at the higher exposure levels ($>10^{18}$NVT). The relative changes in σ_i and/or k_y appeared to be the predominant factors controlling sensitivity to irradiation damage. (auth)

14867 FRACTURE OF URANIUM DIOXIDE. Daniel, J. L. (Battelle-Northwest, Richland, Wash.); Takahashi, Shuichiro. Contract AT(45-1)-1830. pp 1987-97 of Proceedings of the First International Conference on Fracture. Vol. 3. Yokobori, T.; Kawasaki, T.; Swedlow, J. L. (eds.). Japan, Japanese Society for Strength and Fracture of Materials, 1966.

Microplasticity of UO_2 at room temperature was studied. Electron microscopy of microhardness indenter marks showed increased dislocation etch-pit densities, oriented slip bonds, and definite plastic flow of the UO_2. Single crystal fracture surfaces showed similar evidence, but the effect appeared to be overidden by other phenomena in irradiated polycrystalline UO_2. (auth)

14868 IMPLICATIONS OF EMBRITTLEMENT DURING THE LIFE OF A ZIRCONIUM PRESSURE TUBE REACTOR. Nichols, R. W.; Watkins, B. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). 23p. (CONF-660627-11; TRG-Report-1252). DTIE. Gmelin, AED-CONF-66-198-19.

From American Society for Testing and Materials, 69th Annual Meeting, Atlantic City.

Tests were made on Zircaloy-2 pressure tubes in order to assess the effects of brittleness caused by hydrogen impurities. Results from irradiation of notch impact specimens to doses up to 10^{21}n/cm^2 indicated that the embrittlement effect saturates at relatively low doses. It was concluded that even with maximum radiation effects and 400 ppM H_2, the occurrence of intolerable defects due to brittleness is improbable. (J.G.B.)

Ceramics and Cermets

Corrosion and Erosion

Refer to abstracts 14871 and 14908.

Preparation and Fabrication

Refer also to abstracts 14234, 14800, 14808, and 14885.

14869 (BNWL-SA-1079) FABRICATION AND IRRADIATION FACTORS INFLUENCING PLUTONIUM RECYCLE ECONOMICS. Keenan, J. P.; Goldsmith, S.; de Halas, D. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1967. Contract AT(45-1)-1830. 17p. (CONF-670306-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From IAEA Symposium on Uses of Plutonium as a Reactor Fuel, Brussels, Belgium.

The performance characteristics of Pu fuels are being established through an extensive irradiation testing program. This program has included the irradiation of significant quantities of mixed U–Pu oxide fuel elements. Results have shown that fuels enriched with Pu performed equally as well as fuels containing only U. Performance of UO_2–PuO_2 fuel with PuO_2 contents in the range of 0.5 to 6.6 wt % has been evaluated at powers high enough to cause central melting. Prototypic power reactor fuel assemblies have been irradiated to average exposures up to 10,000 MWd/ton. An analytical model has been used to investigate the influence of plant throughput on thermal reactor fuel element costs. A detailed estimate was made of costs at ¼ and ½ ton/day output levels, for fuel elements enriched with U and with high exposure PuO. These costs are compared with previously estimated costs for producing the same fuels at an output of 1 ton/day. Costs have also been extrapolated to cover 5 and 10 ton/day throughput levels. In addition, the fuel model has been used to estimate the cost savings which might result from adding Pu to fuel rods late in the fabrication cycle. The cost savings are not large and could easily be offset by any reduction in fuel performance characteristics. (auth)

14870 (NUMEC-3505-5) PuO_2–ZrO_2–UO_2 FUEL DEVELOPMENT PROGRAM. Progress Report, March 1–June 30, 1965. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Contract AT(30-1)-3505. 59p. (EURAEC-1439). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Developments in studies on the PuO_2–ZrO_2–UO_2 fuel system with compositions including 4, 6, 10, and 12 vol/% PuO_2 in conjunction with 25, 50, and 75 vol/% ZrO_2, with the remainder UO_2. Sinterable-grade powders have been prepared by both ternary co-precipitation and mechanical mixing routes. Two coprecipitation preparations, viz., 10 vol/% PuO_2–50 vol/% ZrO_2–40 vol/% UO_2 and 10 vol/% PuO_2–75 vol/% ZrO_2–15 vol/% UO_2 have been fabricated into ceramic pellets exhibiting densities of 93 and 95 percent of theoretical, respectively. Furthermore, the pellets consisted of one-phase, face-centered-cubic structures. The four preparations which were made by mechanical mixing were 10 vol/% PuO_2–25 vol/% ZrO_2–65 vol/% UO_2; 10 vol/% PuO_2–50 vol/% ZrO_2–40 vol/% UO_2; 10 vol/% PuO_2–50 vol/% ZrO_2·CaO–40 vol/% UO_2 and 4 vol/% PuO_2–75 vol/% ZrO_2–21 vol/% UO_2. The 10 vol/% PuO_2–50 vol/% ZrO_2–40 vol/% UO_2 formulation was fabricated into pellets of 85 percent theoretical density. Pellets prepared from the other formulations were all 90 to 91 percent of theoretical density. All the pellets from mechanically-mixed preparations exhibited single-phase face-centered cubic structures except that of 4 vol/% PuO_2–75 vol/% ZrO_2–21 vol/% UO_2 which contained about 10 percent of a high-ZrO_2 monoclinic phase. Detailed thermophysical studies of the PuO_2–ZrO_2–UO_2 system were initiated and are continuing. Areas of investigation include evaluation of the phase diagram using x-ray studies, metallography, and thermal analysis; thermal expansion and thermal cycling; in addition to water corrosion and air oxidation stability. The preliminary design of the irradiation test capsule has been completed and the detail design is proceeding. Specifications for test capsule components were completed and procurement was initiated. Three capsules are to be irradiated to burnup levels of 10,000, 30,000 and 60,000 MWd/tonne beginning in February 1966. (auth)

14871 (UNC-5132) STUDY OF URANIUM–PLUTONIUM MONOXIDES. Quarterly Progress Report, April 1–June 30, 1965. Forbes, R. L.; Fuhrman, N.; Strasser, A. (United Nuclear Corp., White Plains, N. Y. Development Div.); Andersen, J.; Taylor, K. (Carborundum Co., Niagara Falls, N. Y.). Sept. 15, 1965. Contract AT(30-1)-3305. 45p. (EURAEC-1467). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

UO–PuO-type compositions with C and/or N_2 stabilizers were synthesized by C and U metal reduction routes in He and vacuum. Essentially single-phase, 90 to 95 wt % (UPu)(OC) was produced with oxygen atom fractions of 0.34 to 0.38. (UPu)(ON), could not be fabricated. (UPu)(OCN) materials were produced which contained as high as 92 wt % $(U_{0.9}Pu_{0.1})(O_{0.24}C_{0.36}N_{0.40})$. Specimens of (UPu)(OC) and (UPu)(OCN) materials were subjected to corrosion tests in boiling water. The (UPu)(OC) composition exhibited poor corrosion resistance while the (UPu)(OCN) composition was intact after exposure to boiling water for 73.5 hr. The thermal conductivities of two (UPu)(OC) type compositions calculated from thermal diffusivity measurements were significantly higher than the thermal conductivity of UO_2. (auth)

14872 (WAPD-TM-588) FABRICATION OF FUEL RODS CONTAINING ^{233}U PELLETIZED OXIDE FUELS. Frankhouser, W. L.; Crain, H. H.; Fischer, R. L.; Suldan, J. H.; Eyler, J. H.; Speer, E. L. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Feb. 1967. Contract AT(11-1)-Gen-14. 45p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Approximately 13 kg of U-233 were fabricated into 1 wt % UO_2-ThO_2 and 26 wt % UO_2-ZrO_2 pellets and enclosed in Zircaloy-2 cladding tubes as 1299 blanket and 377 seed rods. The U-233 contained 38 ppM of U-232, and was purified as two batches of liquid $UO_2(NO_3)_2$ immediately prior to processing into powder form. All fuel rods were completed within 95 days of this initial solvent extraction of the nitrate. Overall U yield of nitrate to usable materials was over 90%, and only 14 rods were rejected in welding and all without loss of contained fuel. (auth)

14873 MILL FOR GRINDING CARBIDES. Groshev, V. I.; Maskaev, A. S.; Nezhevenko, L. B.; Poltoratskii, N. I. Porosh. Met., Akad. Nauk Ukr. SSR, No. 1, 108-11(Jan. 1967). (In Russian).

The basic technological regimes for preparing casings and grinding bodies of ZrC and NbC are outlined. It is shown that it is possible to replace grinders encased in BK-8 or BK-6 alloy by grinders with a ZrC or NbC casing for grinding of the corresponding carbides. (auth)

14874 CONTROL OF STOICHIOMETRY IN THE GROWTH OF CRYSTALS OF URANIUM MONOCARBIDE. Ervin, G. Jr. (Atomics International, Canoga Park, Calif.); Smalley, A. K.; Nadler, H. Mater. Res. Stand., 1: 151-9(Nov. 1966).

Specialized zone melting techniques developed for UC, particularly the methods of stoichiometry control, are described. Problems in stoichiometry control because of vapor loss of U when the melting is done in high vacuum and because of solid/liquid distribution effects when the melting is done in inert gas are considered. Temperature measurements of the molten zone combined with chemical analyses of crystallized rods were used to obtain data on phase equilibria near the UC composition. Preparations made by zone melting in vacuum were single crystals of UC, containing UC_2 intergrown with the UC. These preparations could be converted to single-phase single crystals of UC by heat treatment in either H_2 or O_2. It seemed likely that the rates of decarburization of $UC-UC_2$ structures by either oxygen or hydrogen are controlled by the diffusion of C, but perhaps preferentially along grain boundaries, including $UC-UC_2$ interfaces. Other oxygen decarburization experiments showed gradients in the UC_2 content from edge to center as would be expected if the rates are controlled by diffusion in the solid. (BBB)

14875 INVESTIGATION OF THE CONDITION OF FORMATION OF SOLID SOLUTIONS OF CARBIDES INVOLVING SCANDIUM CARBIDE. Samsonov, G. V.; Makarenko, G. N.; Krushinskii, A. N. (Inst. of Material Science Problems, Academy of Sciences, Ukrainian SSR. Kiev Polytechnic Inst.). pp 250-6 of Vysokotemperaturnye Neorganicheskie Soedineniya. Samsonov, G. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1965. (In Russian).

The conditions of formation of the WC-ScC solid solutions in the WC to ScC mole ratio from 1:4 to 4:1 were investigated in vacuo in the 1000 to 2000°C range. The formation of WC-TiC-ScC solid solutions was investigated in vacuo and in hydrogen in the 1000 to 2500°C range. The solid solution products were examined for microhardness. The carbide solid solutions were prepared by reduction of the suitable oxide mixtures by carbon. It was found that the optimum conditions for preparing a solid solution containing 20 mole % ScC and having maximum microhardness are obtained by heating a stoichiometric mixture of oxides with carbon at 1900°C for 1 hr. In the case of reduction in vacuo, the optimum conditions of formation of WC-TiC-ScC solid solutions are: heating of a suitable oxide and carbon mixture for 1 hr at 2000°C or in the case of carbidization in a Tamman furnace, a two-time heating of a $WC-TiO_2-Sc_2O_3-C$ mixture for 1 hr at 2100°C, or heating of a $W-Sc_2O_3-TiO_2-C$ mixture for 1 hr at 2500°C. In general, the mere presence of ScC increases the hardness of the other transition element carbides. (ATD)

14876 EFFECT OF CERTAIN FACTORS ON GROWTH AND FORMATION OF SiC CRYSTALS. Pichugin, I. G.; Smirnova, N. A.; Tairov, Yu. M.; Yas'kov, D. A. (Leningrad Electrotechnical Inst.). pp 309-14 of Vysokotemperaturnye Neorganicheskie Soedineniya. Samsonov, G. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1965. (In Russian).

The growing process of SiC crystals was studied in the 2350° to 2500°C range in an argon atmosphere. Before sublimation, the SiC raw material was degassed at 200°C and 1×10^{-5} mm Hg. The crystal growing duration was 6 to 12 hours. Best quality SiC crystals were obtained using a two-diaphragm crucible. The distance between diaphragms could be varied from 0.5 to 6 mm. It was found that the optimum conditions for growing high-quality homogeneous SiC crystals 6 to 8 mm in diameter (with an average defect density of 200 cm^{-2} and with a large proportion of crystals with defect density less than 30 cm^{-2}) are: a maximum axial and radial temperature variation in the crucible of ±50°C, heating from 2000°C to the desired process temperature at a rate not lower than 20°/min, the diameter of the inner diaphragm equal to 35 mm, and raw SiC grains of 3 to 5 mm in diameter. (ATD)

14877 BORON CARBIDES OF ALKALINE EARTH AND RARE EARTH METALS. Markovskii, L. Ya.; Vekshina, N. V.; Pron', G. F. (Red Banner Inst. of Applied Chemistry, USSR). pp 415-20 of Vysokotemperaturnye Neorganicheskie Soedineniya. Samsonov, G. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1965. (In Russian).

A new class of ternary compounds Me-C-B was obtained using alkaline earth metals and La and Ce. The products obtained were named borocarbides because their chemical activity, and especially, their ability for hydrolytic decomposition resembled properties of carbides rather than the chemically inert hexaborides. Previous studies established the existence of U and Th borocarbides, however, it was also established that the transition metals Zr, Hf, and Ti do not form borocarbides. The data obtained were used for further studies. (R.V.J.)

14878 CHEMICAL PROCESSES DURING CARBOTHERMAL SYNTHESIS OF ALKALINE EARTH METAL BORIDES AND CERTAIN RARE EARTH METAL BORIDES. Vekshina, N. V.; Markovskii, L. Ya.; Pron', G. F. (Red Banner Inst. of Applied Chemistry, USSR). pp 404-14 of Vysokotemperaturnye Neorganicheskie Soedineniya. Samsonov, G. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1965. (In Russian).

A process was found for effective carbothermal production of hexaborides of alkaline earth metals, lanthanum, and cerium. The process produced borides with close to the stoichiometric boride composition. (R.V.J.)

Properties Evaluations

Refer also to abstracts 14838, 14871, and 14902.

14879 (DC-60-1-205) MILESTONE I, JOB 53289: ADVANCED FUEL ELEMENT MATERIALS. Hammons, G. L.; Robertshaw, F. C.; Yario, W. R. (General Electric Co., Cincinnati, Ohio. Aircraft Nuclear Propulsion Dept.). Jan. 27, 1960. Contract AT(11-1)-171. 37p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Results of a study of an advanced fuel element material are presented. The study had as its objective the determination of the potential of the material for 1000 hour operation at 2300°F and, accordingly, whether major component testing is warranted. The material, produced in ribbon form, consists nominally of a powder metallurgy core of Fe-30 Cr-1 Y plus UO_2 clad with wrought Fe-30 Cr-1 Y alloy. The numerous experimental ribbons produced, the processes used in their preparation, and the methods utilized and data obtained in the determination of significant ribbon properties are described. It was concluded that, while the material has a definite potential for 250 to 500 hours, it is not suited for 1000 hour operation at 2300°F. Major component testing is not recommended. (auth)

14880 (DC-60-3-131) ADDENDUM TO REPORTS DC 60-1-204 AND DC 60-1-205 ON ADVANCED FUEL ELEMENT MATERIALS. Bartocci, R. S.; Robertshaw, F. C. (General Electric Co., Cincinnati, Ohio. Aircraft Nuclear Propulsion Dept.). Mar. 16, 1960. Contract AT(11-1)-171. 29p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Additional tests were made on the $FeCrY/FeCrY-UO_2$ system as a fuel element material. Data are given on: oxidation resistance of cladding stock; strength of cladding stock; static oxidation resistance of fueled ribbon; stress-oxidation resistance of fueled ribbon; Cr vaporization and formation of Cr_2O_3 crystals; fuel reduction; metallography of the fueled ribbon; and analytical techniques for Y determination. (P.C.H.)

14881 (EURAEC-1650) DIFFUSION OF RARE GASES IN SOLIDS. Final Report No. 4. Felix, F. (comp.) (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Feb. 1966. Contract 028-64-1TEE(R and D). 42p. (EUR-2848; EU-B-42). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States-Euratom Joint Research and Development Program.

The results of post-activation diffusion (PAD) measurements of rare gases in the solids UO_2, UC, and ThO_2, UO_2, CaF_2, CaO, KF, KCl, KBr, and KI and tritium in AgLi are reported. Remarks concerning the detailed individual representations of the systems and a survey of the measuring methods used are followed by a com-

parison of the temperature dependence of the rare gas release on the basis of the volume diffusion of these systems. The deviations observed from the ideal diffusion kinetics owing to vaporization of the sample and the effect of rare gas traps are discussed in detail in connection with experimental examples. A list of references concerning diffusion measurements on UO_2 and UC is appended. (auth)

14882 (GA-7478) DIFFUSION OF METALLIC FISSION PRODUCTS IN PYROLYTIC CARBON. Gethard, P. E.; Zumwalt, L. R. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Dec. 15, 1966. Contract AT(04-3)-633. 23p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The diffusion of Sr and Cs through thin layers (100μ) of isotropic pyrolytic C was measured over the temperature range from 1000 to 1700°C. Diffusion coefficients observed for Cs were orders of magnitude lower than those for Sr. The diffusion rates for both series were much lower than those observed in polycrystalline graphite, where little difference was seen between Cs and Sr. When constant chemical potential sources were used, chemical- and self-diffusion measurements for Sr gave identical results in the concentration range 1.0×10^{-4} to 2.0×10^{-3} g Sr/g graphite. There was apparently no concentration effect for Cs over the range 1.0×10^{-7} to 1.5×10^{-3} g Cs/g graphite. The difference between Sr and Cs diffusion in pyrolytic C is attributed to the greater steric effect of the pyrolytic C defect structure relative to that of Cs. (auth)

14883 (GEAP-5284) THE EFFECTIVE AXIAL AND DIAMETRAL THERMAL EXPANSION OF UO_2 UNDER A RADIAL TEMPERATURE GRADIENT. Asamoto, R. R.; Perry, K. J.; Zebroski, E. L. (General Electric Co., San Jose, Calif. Advanced Products Operation). Oct. 1966. Contract AT(04-3)-540. 49p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An out-of-pile investigation was undertaken to determine the thermal expansion characteristics of a column of ceramic fuel pellets. The expansion of dished and nondished UO_2 pellets under the influence of radial temperature gradients was studied under conditions of thermal cycling, at temperatures up to fuel melting (2850°C), and with and without axial restraint of the fuel. The effect of limited radial restraint was also observed using tungsten as cladding. Reduced axial expansion with good expansion stability on thermal cycling was found with properly designed dished pellets. (auth)

14884 (NP-16475) PYROLYTIC REFRACTORY MATERIALS FOR SPACECRAFT THRUST CHAMBERS. PYROLYTIC COMPOSITES OF HAFNIUM AND ZIRCONIUM CARBIDES IN GRAPHITE. Report 6115. Period Covered: May 20, 1965–September 20, 1966. Coulbert, C. D. (Marquardt Corp., Van Nuys, Calif.); Waugh, J. S. (Raytheon Co., Waltham, Mass. Research Div.). Dec. 15, 1966. Contract NAS7-373; Subcontract 532655. 183p.

Data are presented on the properties of two carbide–pyrolytic graphite (PG) systems: HfC–PG and PG–ZrC. Progress is outlined on the development of material capability and fabrication techniques. Information is included on density, burst strength, flexural strength, high-temperature creep strength, Young's modulus and Poisson's ratio, thermal expansion, and thermal conductivity. The microstructure, residual stress, heat treatment and growth, preferred orientation and lattice parameters, and oxidation and erosion of the carbide–PG materials are discussed. (J.H.M.)

14885 (RISO-139) METALLURGY DEPARTMENT ANNUAL PROGRESS REPORT FOR THE PERIOD ENDING MARCH 31ST, 1966. (Danish Atomic Energy Commission, Risoe. Research Establishment). Sept. 1966. 49p. Dep. mn.

Developments are reported for studies on: UO_2–Zircaloy fuel elements for water reactors; metallography of Zircaloy-2; hydrogen determination in Zircaloy-2; examination of failed SAP tube; metallography of irradiated U alloys, UO_2, and SAP; corrosion of Zircaloy-2 and a standard MTR-type fuel element; uptake of hydrogen from terphenyls by SAP; texture of extruded Al–Al_2O_3; rolling textures in fcc metals and alloys; hydrogen determination in SAP; fission-fragment damage in dilute Al–Mg alloys; production of Al–Al_2O_3 single crystals; mechanical properties and structure of Al–Al_2O_3; creep properties of Al–Al_2O_3; activation energy of Al–Al_2O_3; irradiation growth of dilute uranium alloys; instrumentation; development and properties of MTR-type fuel element and Zircaloy–UO_2; creep properties of Al–Al_2O_3 products made from atomized aluminum powders; grain size of Al powder; and preparation of UO_2 pellets. (P.C.H.)

14886 (UCRL-16360) ELASTIC PROPERTIES OF MULTIPHASE CERAMIC SYSTEMS. Hasselman, D. P. H.; Fulrath, R. M. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 22, 1965. Contract W-7405-eng-48. 30p. (CONF-651125-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Seminar on Determination of Physical Properties of Materials through Sonic Resonant Methods, Columbus, Ohio.

The effects of various types of dispersion on Young's modulus of an isotropic homogeneous matrix in terms of the elastic properties, volume fractions, and particle shape of the dispersant are discussed. A short review is given of the theoretical contributions in the literature. The multicomponent materials investigated consisted of a sodium borosilicate glass containing small volume fractions of spherical pores, crushed sapphire, and spherical particles of W. Young's modulus of elasticity was determined by a flexural resonance technique. The results are compared with those obtained previously by others and with theory. (auth)

14887 GALLOCHALCOGENIDES OF RARE-EARTH METALS. Samsonov, G. V.; Paderno, Yu. B.; Murguzov, M. I.; Fedorchenko, V. P.; Karaev, Z. Sh. Porosh. Met., Akad. Nauk Ukr. SSR, No. 1, 99-104(Jan. 1967). (In Russian).

On the basis of the data in the literature it was concluded that the atoms of rare earth metals are arranged in a lattice. The electroresistivity and thermal emf were measured over a range from room temperature to 1100°K. It is shown that $NdGaSe_3$ is a semiconductor with a width of prohibited zone and ionization energy of the impurity level of 1.78 and 0.77 eV, respectively. The semiconductor nature of the conductivity of $NdGaSe_3$ is explained on the basis of electronic structure of isolated atoms with their ionization potentials involved. An assumption is advanced as to the nature of the chemical bond in chalcogenides of rare earth metals. (auth)

14888 EFFECT OF ALLOYING ON THE ELECTROCONDUCTIVITY OF CERIUM SULFIDE. Goryachev, Yu. M.; Kutsenok, T. G. Porosh. Met., Akad. Nauk Ukr. SSR, No. 1, 95-8 (Jan. 1967). (In Russian).

The effect of alloying on the electroconductivity of Ce_2S_3 was considered. The most effective alloying of Ce_2S_3 was with compounds of Li, Mg, and Ba. (auth)

14889 CHANGE IN THE ELECTRO- AND THERMOPHYSICAL PROPERTIES IN PSEUDOBINARY ALLOYS ALONG THE BEAM $ZrC_{0.82}$–$ZrN_{0.85}$ OF THE ZIRCONIUM–NITROGEN–CARBON SYSTEM. Neshpor, V. S.; Vil'k, Yu. N.; Danisina, I. N. Porosh. Met., Akad. Nauk Ukr. SSR, No. 1, 89-94(Jan. 1967). (In Russian).

Dependence of the variation in electroconductivity, absolute differential thermal emf and the characteristic temperature on the chemical composition was established for alloys of the pseudobinary region of the state diagram of Zr–N–C hardened from a temperature of 2000°C. The nature of the change in value of the electroconductivity, thermal conductivity, and characteristic temperature indicated that in the system ZrC–ZrN a continuous series of solid solutions is formed with unlimited solubility of the components in one another. (auth)

14890 FUSION POINT IN THE SYSTEMS ZrC–HfC, TaC–ZrC, TaC–HfC. Andrievskii, R. A.; Strel'nikova, N. S.; Poltoratskii, N. I.; Kharkhardin, E. D.; Smirnov, V. S. Porosh. Met., Akad. Nauk Ukr. SSR, No. 1, 85-8(Jan. 1967). (In Russian).

The existence of a maximum in the fusion point in the systems TaC–ZrC and TaC–HfC ($TaC \cdot 1ZrC$, 3890°C and $4TaC \cdot 1HfC$, 3990°C); no maximum was found in the ZrC–HfC system. A microstructural investigation showed that the absence of a maximum in the ZrC–HfC system is not connected with the presence of free carbon in the samples. In the systems TaC–ZnC and TaC–HfC considerable decarbonization of the samples was found on heating to temperature close to the fusion points. It was assumed that the high fusion points for the composition $4TaC \cdot 1HfC$ and $8TaC \cdot 1ZrC$ are a result of a shift in stoichiometry during the experiment. (auth)

14891 PHYSICAL PROPERTIES OF LANTHANUM DISILICIDE IN THE HOMOGENEITY REGION. Rud, B. M.; Paderno, Yu. B. Porosh. Met., Akad. Nauk Ukr. SSR, No. 1, 81-4(Jan. 1967). (In Russian).

The existence of a continuous transition between structures of type α-$ThSi_2$ and α-GdSi in the region of homogeneity of $LaSi_2$, detected by the roentgenostructural method is confirmed. A decrease in the statistical weight of sp^3-hybridization of Si electrons causes rhombic distortion of the structure. With an increase in deficit of Si atoms in $LaSi_2$, there is an increase in the specific electric resistivity and Hall's coefficient, due to filling of the 3p-band of Si. (auth)

14892 INVESTIGATION OF HEXABORIDES OF RARE-EARTH METALS BY THE EPR METHOD. Vlasova, M. V.; Sorin, L. A.; Shcherbina, V. I. Porosh. Met., Akad. Nauk Ukr. SSR, No. 1, 70-2(Jan. 1967). (In Russian).

At 300°K for GdB_6 $\Delta = 460$ oe, $g = 2.01$; for EuB_6, $\Delta = 940$ oe, $g = 1.98$; at 77°K the respective values are $\Delta = 520$ oe and $g = 2.03$;

Δ = 1080 oe and g = 2.15. The increment in g is evidently due to failure to take into consideration the spin effect anomaly at the given temperature. Broadening of the resonance curves of paramagnetic absorption with decrease in temperature is evidently connected with magnetic ordering lying below 77°K. (auth)

14893 THERMODYNAMIC PROPERTIES OF ZIRCONIUM AND HAFNIUM CARBIDES OVER THE RANGE OF 298 TO 2500°K. Bolgar, A. S.; Guseva, E. A.; Fesenko, V. V. Porosh. Met., Akad. Nauk Ukr. SSR, No. 1, 40-3(Jan. 1967). (In Russian).

The mixing method was used to determine values of the enthalpy of ZrC and HfC over the temperature range from 1300 to 2500°K. On the basis of the data obtained and the data in the literature, the enthalpy, heat capacity, entropy, and reduced potentials of the investigated carbides were determined over the temperature range from 298 to 2500°K. (auth)

14894 INFLUENCE OF HIGH CONDUCTIVITY LAYERS ON THE THERMAL BEHAVIOR OF CERAMIC FUEL ELEMENTS. Betta, V. (Univ., Naples). Termotecnica (Milan), 20: 685-90 (Dec. 1966). (In Italian).

Modifications of the thermal conditions in ceramic fuel elements following the introduction of high-thermal-conductivity layers were studied. The effects of geometric parameters and of the mechanical characteristics of the materials forming the fuel element on decreases in the maximum temperature in the fuel elements are discussed using simplifying hypotheses. Some particular cases are examined using the finite difference method. (tr-auth)

14895 ON THE SUPERSTRUCTURES OF Ta_2O_5 AND Nb_2O_5. Spyridelis, J.; Delavignette, P.; Amelinckx, S. (SCK-CEN, Mol, Belg.). Phys. Status Solidi, 19: 683-704(Feb. 1, 1967).

The superstructures of Ta_2O_5 and Nb_2O_5 are studied. The observations made support the assumption that these, and related crystals, have a "shear structure" and that this shear structure can be observed directly. It is shown that the size of the unit cell depends on the exact stoichiometry of the compound. A model is proposed which explains both the details of the diffraction pattern and the geometry of the line system. (auth)

14896 DETERMINATION OF THERMAL CONDUCTIVITY AND ELECTRIC RESISTANCE OF ZrC, HfC, NbC, AND TaC AT HIGH TEMPERATURES. Paderno, Yu. B.; Barantseva, I. G.; Yupko, V. L. (Inst. of Materials Science Problems, Academy of Sciences, Ukrainian SSR). pp 199-204 of Vysokotemperaturnye Neorganicheskie Soedineniya. Samsonov, G. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1965. (In Russian).

The thermal conductivity and the electrical resistance of ZrC, HfC, NbC, and TaC were determined in the 1370° to 3270°K range. The samples were 8 mm in diameter and 15 to 18 mm in length. The hole depths were 3.5 to 3.7 and 1.8 to 2.0 ohm, their diameter was 0.9 mm, the distance separating them was approximately 5 mm, and the distance between the potential zones was 7 to 7.5 mm. The apparatus used for the measurements is diagrammed. The composition of the carbide samples is shown in a table. (ATD)

14897 INTERACTION BETWEEN THE CARBIDES AND THE OXIDES OF TRANSITION METALS. Kosolapova, T. Ya.; Fedorus, V. B. (Inst. of Materials Science Problems, Academy of Sciences, Ukrainian SSR). pp 243-9 of Vysokotemperaturnye Neorganicheskie Soedineniya. Samsonov, G. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1965. (In Russian).

The interaction between oxides and carbides of La, Ti, Zr, Ga, V, Nb, and Cr in vacuo at 1000° to 2000°C was investigated. The briquettes of the oxide and carbide mixtures were heated at 10^{-3} mm Hg from 1000°C to the melting temperature of the reaction products when it was lower than 2000°C, and from 1000°C to 2000°C when the melting temperature of the reaction products was greater than 2000°C. It was found that the interaction between oxides and carbides depends upon the atomic number of the transition elements of the respective oxides and carbides. The interaction increased in the order of group IV, V, and VI of the periodic system. The dependence of the free energy change for reaction between oxides and carbides upon temperature is shown in a figure. The difference of the heat of formation of carbides and oxides of Zr, Nb, Mo, Ti, V, and Cr is graphed. (ATD)

14898 MEASUREMENT OF THE THERMAL EXPANSION COEFFICIENTS OF ZrC, HfC, NbC, AND TaC AT HIGH TEMPERATURES. Paderno, Yu. B.; Dudnik, E. M.; Andreeva, T. V.; Barantseva, I. G.; Yupko, V. L. (Inst. of Material Science Problems, Academy of Sciences, Ukrainian SSR). pp 293-6 of Vysokotemperaturnye Neorganicheskie Soedineniya. Samsonov, G. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1965. (In Russian).

The thermal expansion of ZrC, HfC, NbC, and TaC was studied in the 1370° to 3170°K range. The thermal expansion was measured in a vacuum chamber (10^{-2} mm Hg) in which carbide samples (8 mm in diameter and 15 to 18 mm in length) were heated electrically. The carbide samples were prepared by a hot-pressing technique and the temperature was measured with an OPM-19 micropyrometer. The individual carbide samples had the following porosities: ZrC, 19 to 24%; HfC, 22 to 28%; NbC, 13 to 18%; and TaC, 27%. The dependence of the relative thermal expansion ($\Delta l/l$) of the carbide samples upon temperature is graphed. A table gives the average values of the thermal expansion coefficients for various carbides. (ATD)

14899 THERMAL CONDUCTIVITY AND MAGNETIC SUSCEPTIBILITY OF ALKALINE EARTH AND RARE EARTH METAL HEXABORIDES. L'vov, S. N. (Kherson Teachers Coll., USSR); Nemchenko, V. F.; Paderno, Yu. B. pp 445-50 of Vysokotemperaturnye Neorganicheskie Soedineniya. Samsonov, G. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1965. (In Russian).

Thermal conductivity and magnetic susceptibility of alkaline earth and rare earth metals and Y were studied at room temperature. Tabulations of the calculated magnitudes of electron and phonon heat components of Ca, Sr, Ba, Y, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Yb, and Tm hexaborides showed that the thermal conductivity is about three times higher than that of the pure metals. It was also shown that the effective atomic magnetic moments in rare earth hexaborides are identical with those of their pure metals. However, the effective atomic magnetic moments of alkaline earth metal (Ca and Ba) hexaborides are considerably higher than those of the pure metals, indicating the change of charge in the atoms of alkaline earth metals. Thus, the results suggest that in the alkaline earth metal hexaborides, the electron levels are partially saturated at the expense of boron atom electrons. (R.V.J.)

14900 THERMAL CONDUCTIVITY OF IV-VI GROUP TRANSITION METAL BORIDES. L'vov, S. N.; Nemchenko, V. F.; Mal'kov, P. I. (Kherson Teachers Coll., USSR). pp 451-5 of Vysokotemperaturnye Neorganicheskie Soedineniya. Samsonov, G. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1965. (In Russian).

Tabulated data on the thermal and electric conductivities of the IV–VI group transition metals and their borides at room temperature showed certain regularities in the changes of thermal conductivity coefficients in the diborides. The thermal conductivities of diborides of group-IV elements were greater than groups V and VI, respectively. The thermal conductivities of the group-IV metal diborides are higher than those of their pure metals, whereas in group V and, especially, in group VI the thermal conductivities of the pure metals are higher than in their diborides. (R.V.J.)

14901 BERYLLIUM OXIDE FOR NUCLEAR APPLICATION. Smith, R. (Australian Atomic Energy Research Establishment, Lucas Heights, New South Wales). 35p. (CONF-661003-19). DTIE.

From AIME Nuclear Metallurgy Symposium on High Temperature Nuclear Fuels, Delavan, Wis.

A review is given of recent work on the properties and performance of beryllia. Attention is confined mainly to one grade of BeO with a grain size less than 5 μ and a density of 2.86 to 2.90 g cm^{-3}, fabricated by isostatic pressing and sintering from sulfate-derived powder. Topics considered are: fabrication, microstructure and permeability, thermal expansion and thermal conductivity, mechanical behavior and properties, and the effects of irradiation. The main limitation on the use of BeO as a nuclear material is still the fast-neutron dose that the material will withstand without microcracking. This limitation is less severe at high temperatures and can be overcome if the material can be annealed periodically at 1000°C to remove accumulated strain. (auth)

Structure and Phase Studies

14902 (N-66-26236) GRAPHITE–METAL COMPOSITES. Quarterly Report No. 3, February 1–May 1, 1966. Harada, Y. (IIT Research Inst., Chicago, Ill.). Apr. 21, 1966. Contract NASr-65(09). 42p. (NASA-CR-74904; IITRI-G6003-3). CFSTI $3.00 cy, $0.65 mn.

Developments are reported for studies on liquid phase sintering in graphite–metal composites during hot pressing at elevated (2800 to 3100°C) temperatures. Compositional studies included a broad study of Ta and Nb composites having metal contents of 50 to 90 wt %. In addition, systems containing Mo, V, and Ti, were examined in a continuing general study of metal carbide–graphite composites and their properties. The use of metal oxides as the metal source was examined, and experiments were conducted to determine actual metal content in fabricated billets. Physical

property measurements were made at elevated temperatures, and thermal shock tests were initiated. (STAR)

14903 (UCRL–16887) THE EXAMINATION OF POLYCRYSTALLINE MgO BY TRANSMISSION ELECTRON MICROSCOPY. Langdon, Terence G.; Pask, Joseph A. (California Univ., Berkeley. Lawrence Radiation Lab.). Nov. 1966. Contract W-7405-eng-48. 17p. (CONF-660619-7). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 3rd International Materials Symposium on Ceramic Microstructure, Berkeley, Calif.

The possibility of using transmission electron microscopy for studying deformation mechanisms in polycrystalline MgO was investigated. The results showed that electron microscopy is a useful tool for this particular study. However, it is imperative that the specimens used approximate to theoretical density, owing to the difficulty of preparing thin foils of even slightly porous material. (P.C.H.)

14904 PHASE TRANSFORMATIONS OF RARE EARTH SESQUIOXIDES La_2O_3, Nd_2O_3, Pr_2O_3, AND Y_2O_3. Mehrotra, P. N.; Chandrashekar, G. V.; Rao, C. N. R.; Subbarao, E. C. (Indian Inst. of Tech., Kanpur, India). Trans. Faraday Soc., 62: 3586-90(Dec. 1966).

The cubic (C) form of La_2O_3 was prepared and its transformation to the hexagonal (A) form was found to take place at ~590°C. The C → A transformation of Nd_2O_3 took place at 550°C. The temperatures as well as the energies of activation of the phase transformations of the rare earth sesquioxides varied with the size of the cation. Y_2O_3 underwent a reversible phase transformation in the temperature range 400 to 900°C. The phase transformations of La_2O_3, Nd_2O_3, and Pr_2O_3 were followed by electrical conductivity measurements. Presence of water vapor lowered the activation energy for the conduction process as well as the temperature of transformation. (auth)

14905 HIGH TEMPERATURE RARE EARTH–BORON–CARBON STUDIES. III. LnB_2C_2 AND THE TERNARY PHASE DIAGRAM. Smith, P. Kent; Gilles, Paul W. (Univ. of Kansas, Lawrence). J. Inorg. Nucl. Chem., 29: 375-82(Feb. 1967).

The identification and characterization of a rare earth diboride dicarbide phase, LnB_2C_2, and the phase relationships in the ternary Ln–B–C systems were established by chemical and x-ray diffraction analysis of samples prepared by arc-melting techniques. The five ternary phases shown in the phase diagram are different from the ternary phases in the actinide systems. Precise tetragonal lattice parameters for the phase LnB_2C_2, which was designated LnB_x by previous workers, showed approximately a 13% decrease in c_0 but only a 1% decrease in a_0 throughout the rare earth series. These variations suggest a structure consisting of tightly bound light atoms in sheets loosely bound to one another and separated by metal atoms. (auth)

14906 INTERACTION BETWEEN NIOBIUM CARBIDE AND TUNGSTEN. Vil'k, Yu. N.; Avarbe, R. G.; Neshpor, V. S.; Ryzhkova, T. P.; Omel'chenko, Yu. A. (Red Banner Inst. of Applied Chemistry, USSR). pp 219-36 of Vysokotemperaturnye Neorganicheskie Soedineniya. Samsonov, G. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1965. (In Russian).

The phase equilibrium of W and NbC, $NbC_{0.98}$ (from 5 to 95 wt % W), and $NbC_{0.85}$ (from 5 to 50 wt % W), was examined by x rays in the 2000° to 3000°C range. It was found that the system has true two-phase regions ($\alpha + \delta$ solid solution based on W and W_2C, $\alpha + \gamma$ solid solution based on W and NbC, and $\gamma + \beta$-solid solution based on NbC and Nb_2C) and also a region of a three-phase equilibrium, $\alpha + \beta + \gamma$. In the tertiary W–Nb–C region the liquid phase occurs below 2600°C. In the tertiary W–Nb–C region binary eutectic $\alpha + \beta$, a tertiary eutectic $\alpha + \beta + \gamma$, and a tertiary eutectic $\alpha + \delta + \gamma$ were detected. The hypothetic profile of the Nb–W–C system is shown. The dependence of the lattice parameter of the α phase upon Nb content and of the NbC solid solution upon WC content are graphed. The melting ranges and the possible shape of the polythermal profile of the W–NbC system are also shown. (ATD)

14907 INTERACTION BETWEEN MOLYBDENUM AND TITANIUM CARBIDE. Eremenko, V. N.; Velikanova, T. Ya. (Inst. of Material Science Problems, Academy of Sciences, Ukrainian SSR). pp 265-73 of Vysokotemperaturnye Neorganicheskie Soedineniya. Samsonov, G. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1965. (In Russian).

Interaction between molybdenum and titanium carbide in the 1.2 to 90 mole % TiC range was investigated by x-ray and metallographic techniques. Samples of Mo–TiC in various ratios were prepared by prolonged melting technique as well as by fusion in vacuo (10^{-4} mm Hg) of mixtures of TiC with Mo at 1850° to 2000°C. The oxygen was removed from the samples by reduction with hydrogen at 1000°C. It was found that the Mo–TiC system is quasibinary and exhibits a eutectic-type crystallization pattern. The eutectic temperature is 2175 ± 15°C. The solubility of Mo in TiC at the eutectic temperature is 37 mole % and at 2000°C it is 25 mole %. The solubility of TiC in Mo at the eutectic temperature is within the 3.5 to 4.5 mole % range and at 2000°C it falls within the 2 to 2.5 mole % range. The temperature dependence of the thermodynamic activity of carbon in TiC and Mo_2C is shown. A phase diagram of the quasibinary Mo–TiC system is also given. (ATD)

14908 ZIRCONIUM–VANADIUM–BORON SYSTEM. Cherkashina, N. V.; Fedorov, T. F.; Shamrai, F. I. (Baikov Inst. of Metallurgy, USSR). pp 421-8 of Vysokotemperaturnye Neorganicheskie Soedineniya. Samsonov, G. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1965. (In Russian).

The phase structure and oxidation susceptibility of the binary sections, ZrB_2–VB_2 and Zr–VB_2, of the Zr–V–B system were investigated by x-ray, microhardness, and gravimetric techniques. The individual diborides were prepared by fusion in a Tamman furnace in a hydrogen atmosphere of the oxides and carbides according to formulas $V_2O_5 + B_4C + 4C = 2VB_2 + 5CO$ and $2ZrO_2 + B_4C + 3C = 2ZrB_2 + 4CO$. The intercomponent molar ratio varied from 1:9 to 9:1 in the case of the ZrB_2–VB_2 system and from 1:19 to 19:1 for the Zr–VB_2 system. For all the ratios, the ZrB_2–VB_2 system was found to be a true two-phase one. After oxidation (1 hour heating in oxygen at 1200°C) the ZrB_2–VB_2 samples gained weight due to the predominant formation of ZrO_2. It was found that ZrB_2 contributed to greater oxidation stability of the ZrB_2–VB_2 alloys. It was found that Zr–VB_2 alloys containing more than 50 mole % Zr had a face-centered lattice with a = 4.618 kx [where 1kx = 1/1.00202 Å]. Alloys containing 80 and 90 mole % Zr had a cubic face-centered lattice with a = 4.63 kx. When subjected to oxidation at 1200°C all samples of the Zr–VB_2 system corroded throughout and turned into powder. (ATD)

14909 STRUCTURE AND SINTERING BEHAVIOR OF U_3O_8. Steeb, S.; Brucklacher, D. (Max-Planck-Institut fuer Metallforsching, Stuttgart). J. Less-Common Metals, 11: 263-72(1966). (In German).

A modification of U_3O_8, called p-U_3O_8, is described; it can be produced at room temperature from α-U_3O_8 under pressures of more than 50 kp/cm². The lattice of p-U_3O_8 is orthorhombic with α = 6.70, b = 11.93 and c = 4.14 × 8 Å, space group $C2_12_12_1$, M = 16. p-U_3O_8 is formed by displacing some of the O atoms already present in α-U_3O_8. The p-U_3O_8 transforms in air (760 torr) or in Ar above 1100°C into O-deficient α-U_3O_8. Under vacuum (10^{-5} torr) this transformation already takes place at about 200°C. Investigation of sintering behavior showed shrinkage of the sintered bodies during cyclic heat treatment. These bodies possess a negative expansion coefficient of about 10^{-6} degrees^{-1}. Observations of microstructure, measurements of texture, and density of p-U_3O_8 are described. A literature survey of crystallographic data of the oxides between $UO_{2.5}$ and U_3O_8 is given. (auth)

Radiation Effects

Refer also to abstracts 14869, 14885, and 15747.

14910 (GA–7333) ADVANCED BERYLLIUM OXIDE CONCEPTS. Quarterly Progress Report for the Period Ending June 30, 1966. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). July 29, 1966. Contract AT(04-3)-187. 26p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Data on fission product release from sweep capsule F-7 containing BeO-matrix fuel are reported. Information is included on preparation of BeO samples under fabrications conditions comparable to those for BeO matrix fuel. Data and information are also included on Cs diffusion in BeO. Properties of UOX BeO powders were examined and data are included on sintering powders of this grade. Data are also included on radiation and temperature effects on BeO-matrix fuel. Other data and information are included on properties of irradiated and unirradiated graphite. (J.R.D.)

14911 (NP–16530) DISPOSITIF POUR LA MESURE DE RESISTIVITE ELECTRIQUE ENTRE 77°K ET 420°K DE GRAPHITES IRRADIES A 77°K. (Apparatus for the Measurement of the Electric Resistivity Between 77 and 420°K in Graphite Irradiated at 77°K). Bonjour, E.; Da Silva Pereira, B. (Commissariat a l'Energia Atomique, Grenoble (France). Centre d'Etudes Nucleaires). July 1965. 17p. (In French). Dep. mn.

The development and construction of an apparatus for measurement of the electric resistivity of graphite samples between 77 and 420°K is described. The device permits thermal annealing for study of the evolution of the electric resistivity during the recovery of salts irradiated by neutrons at 77°K. As examples curves of resistivity variations for anneals normalized to the initial variation of 77°K are given for pulse annealing of 5°K per 150 sec. The anneal

profiles obtained are very precise. They show a well-defined substate in the antiannealing region from 120 to 160°K. The precision of the measurements is illustrated by the superposition of curves obtained on three different samples irradiated at identical doses. (J.S.R.)

14912 STORED ENERGY IN GRAPHITE AND OTHER REACTOR MATERIALS. Wittels, M. C. Nucl. Safety, 8: 134-7(Winter 1966-1967).

Theoretical and experimental studies of stored-energy phenomena in graphite, Mo, and BeO are reviewed. The investigations related to reactors have included the Soviet IR Reactor and the U. K. Stage I Calder reactors. The latter studies were directed toward 20-year safety projections. Results of experimental studies of electron-irradiated graphite and reactor-irradiated Mo and BeO have been related to fundamental phenomena. (auth)

14913 HIGH TEMPERATURE REACTOR MATERIALS. Huddle, R. A. U.; Conde, J. F. G.; Graham, L. W. (United Kingdom Atomic Energy Authority, Winfrith, Eng.). J. Brit. Nucl. Energy Soc., 5: 345-60(July 1966).

The materials used in the primary circuit of the Dragon Reactor Experiment are described and reference is made to the requirements of a large high temperature power reactor. The main emphasis is however on graphite and fuel. The development of low permeability and back sweeping graphites necessary for the purged fuel concept—as used in the Dragon Reactor—is described and the significance of irradiation damage in the reactor experiment and to the requirements of power reactors is discussed. The coated particle fuel concept is dealt with in some detail. The choice of the various methods developed is discussed in relation to the operational and economic requirements and the results obtained from the irradiation program are summarized. All major objectives of the materials program were achieved and reference is made to the future program for proving the various components of power reactors under operational conditions. (auth)

14914 INVESTIGATION OF THE BEHAVIOR OF NONMETALLIC REACTOR MATERIALS SUBJECTED TO NEUTRON IRRADIATION. Koval'chenko, M. S.; Samsonov, G. V. (Inst. of Material Science Problems, Academy of Sciences, Ukrainian SSR). pp 456-64 of Vysokotemperaturnye Neorganicheskie Soedineniya. Samsonov, G. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1965. (In Russian).

The literature on the effect of neutron irradiation on structure and mechanical properties of TiB_2, TiB_2–Ti cermet, FeB–Fe_2B, GaB_6, Cr–Al_2O_3 cermet, SiC, Ti_2C, Mo_2C, UC, UC_2 and Mo_2C is reviewed. The behavior of these high-temperature materials under 10^{16} to 10^{21} neutrons/cm^2 density and 0° to 1000°C indicates their usefulness for various applications in nuclear reactors. Under neutron irradiation of boron-containing materials the following cleavage reaction occurs: $_5B^{10} + {}_0n^1 = {}_3Li^7 + {}_2He^4$. It was found that the stability of borides declines with increasing covalent character of the bondings within boride crystals. The neutron irradiation of high-temperature materials results in their increased hardness. The increase in microhardness $\Delta H = H - H_0$ (where H_0 is microhardness of nonirradiated material) due to irradiation with 10^{18} and 10^{18} neutrons/cm^3 is 31.8% and 37.5% respectively for titanium carbide, 46.5% and 50.0% respectively for Mo_2C, and 56.8% and 63.3% for GaB_6. (ATD)

14915 CLUSTERING OF DEFECTS IN NEUTRON-IRRADIATED BERYLLIUM OXIDE. Rau, R. C.; Chase, G. A. (General Electric Co., Cincinnati). Phys. Status Solidi, 19: 645-54 (Feb. 1, 1967). (GE-TM-66-8-8; CONF-660806-2).

Transmission electron microscopy and x-ray diffraction have been combined to study clustering of defects in BeO irradiated to neutron dosages ranging from 0.5 to 11.7×10^{20} nvt at pile ambient temperature (≈100°C). Dot clusters which form in the microstructure at dosages greater than about 1.0×10^{20} nvt are interpreted as being small interstitial loops, oriented on basal planes. X-ray diffraction patterns contain duplex peaks consisting of sharp components, which reflect changes in the bulk lattice, and broad components which are related to the basal clusters. The observations are consistent with a model containing interstitial basal clusters and random point interstitials, but do not necessarily rule out the presence of point vacancies. (auth)

14916 IRRADIATION BEHAVIOR OF Al–SiO_2 COMPOSITES. Piggott, M. R. (Atomic Energy of Canada Ltd., Chalk River, Ont.). 4p. (CONF-660824-2). DTIE. Gmelin, AED-CONF-66-294-1.

From 5th Conference of Metallurgists, Toronto.

Tensile tests on Al-clad SiO_2 composites indicated an average strength at 20°C of 83 compared with 5 to 7 kg/mm^2 for Al alone. Irradiation of both coated and uncoated SiO_2 composites in NRX reactor caused an increase of strength about 30%. Similar irradiations on both coated and uncoated SiO_2 fibers showed strength reductions by thermal-neutron bombardment while control samples held at 200°C (estimated temperature of a reactor) showed no significant reduction in strength. Since no obvious changes in microstructure were visible and microhardness tests indicated no significant hardening of the Al, no explanation could be made for this increase in strength. (P.C.S.)

14917 MICROSTRUCTURAL EFFECTS IN IRRADIATED URANIUM DIOXIDE DUE TO THE FORMATION OF FISSION PRODUCTS. Bradbury, B. T.; Lambert, J. D. B.; Whapham, A. D. (Atomic Energy Research Establishment, Harwell, Eng.). 15p. (CONF-660619-6). DTIE. Gmelin, AED-CONF-66-204-14.

From 3rd International Materials Symposium on Ceramic Microstructure, Berkeley, Calif.

Both solid and gaseous fission products are generated during the irradiation of UO_2, and the dimensional stability of the oxide fuel is controlled by the behavior of these fission products once they are formed. The swelling rate due to fission products, which accumulate in the fuel, varies from one material to another and depends critically on the operating conditions of the fuel. Detailed microscopy after irradiation reveals the distribution and concentration of retained fission products, and is important in evaluation of the irradiation performance of fuel. Irradiated UO_2 in the form of particles dispersed in a stainless steel matrix, as thin slices of fuel and as small cylindrical pellets were studied by optical microscopy, surface replica, and transmission electron microscopy and electron probe microanalysis. Some of the observations relating to the behavior of the solid and gaseous fission products are described. (auth)

14918 IRRADIATION STUDY OF UO_2–STAINLESS STEEL AND $(Pu,U)O_2$–STAINLESS STEEL CERMET FUELS IN ROD AND PLATE GEOMETRY. Lambert, J. D. B. (Atomic Energy Research Establishment, Harwell, Eng.). 26p. (CONF-661003-18). DTIE.

From AIME Nuclear Metallurgy Symposium on High Temperature Nuclear Fuels, Delavan, Wis.

Three irradiations were made to determine the dimensional stability of miniature cermet elements containing 30 to 60 vol % oxide dispersed in, and clad with, type-316L stainless steel. The specimens irradiated were clad plates and rods containing spherical UO_2 particles and sealed cans of pellets containing angular and spherical $(Pu,U)O_2$ particles. Surface temperatures varied from 500 to 675°C and burnups were in the range 1 to 10% of heavy atoms. After irradiation, the UO_2-stainless steel plates and rods had undergone volume increases, which were caused by a swelling rate in the UO_2 of about 2% per 1% burnup of U atoms, although initially the matrix had forced the UO_2 to swell into its own voidage. In contrast, the $(Pu,U)O_2$-stainless steel rods exhibited no measurable dimensional change, and in these elements both the initial particle density and burnups were such that no appreciable swelling occurred in the cermet pellets. Thus, particle voidage in a cermet appears to delay the onset of serious swelling. Finally, cermet rods are probably more stable than plates because, once particle swelling has caused failure of the steel matrix, plates crack along their centerplane and bulge appreciably, whereas rods fail uniformly by surface cracking. (auth)

Plastics and Other Materials

Refer also to abstract 15654.

14919 (ISS-66/34) RICERCHE TECNOLOGICHE SULLA RESISTENZA MECCANICA DEL FILM MONTIVEL (POLIESTERE) ESPOSTO A RADIATION γ. (Technological Studies of the Mechanical Resistance of the Montivel Film (Polyester) Exposed to γ-Radiation). Crateri, R. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Oct. 4, 1966. 12p. (In Italian). Dep. mn.

Some results of mechanical resistance measurements on "Montivel" film, new or exposed to γ rays, are shown. A Montivel safety flange to be used near radiation sources is described, together with results of some tests of this device. (auth)

14920 (N-66-38945) EVALUATION OF HIGH TEMPERATURE STRANDED HOOK-UP WIRE. Moore, Harold J. Jr.; Donnelly, James H. (National Aeronautics and Space Administration, Huntsville, Ala. George C. Marshall Space Flight Center). June 21, 1966. 55p. (NASA-TM-X-53522). CFSTI $3.00 cy, $0.65 mn.

Selected wires and insulation for space vehicle and ground support equipment applications were evaluated. The types of wire tested were Sn-coated Cu with irradiated polyolefin insulation; a Sn-coated Cu with irradiated crosslinked polyalkene and a jacket of radiation-crosslinked polyvinylidene fluoride (Kynar);

Teflon (TFE) insulated fine Ag; Teflon insulated Ag alloy; and Teflon insulated Ni-plated Cu with a final plating of Ag. Physical, electrical, environmental, and metallurgical testing included measuring of flexibility, tensile strength, conductivity, insulation resistance, temperature resistance, and corrosion resistance. Performance was evaluated in welding, soldering, and stripping tests. The test results will aid in the selection of conductors and insulation materials. (STAR)

14921 (N-66-39911) RADIATION EFFECTS ON LASERS. Technical Report, July 1, 1965-May 31, 1966. Compton, D. M. J.; Cesena, R. A. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Sept. 21, 1966. Contract NAS12-32. 77p. (NASA-CR-79108; GA-7274). CFSTI $3.00 cy, $0.65 mn.

A discussion is given of the mechanisms by which space radiation effects on lasers can occur, and of a suitable choice of parameters to be measured. These include active tests; measurements of coherence and of near and far field patterns; passive tests; optical transmission measurements; and scattering of transmitted gas laser light. Methods of measuring these parameters were developed and applied to optically pumped lasers such as ruby, $CaWO_4$: Nd, YAg : Nd and Glass : Nd, and GaAs diode injection lasers, before and after irradiation with 32 MeV protons, 30 MeV electrons, and reactor γ rays. For GaAs diodes, irradiation does not change the current voltage curve, but degrades the optical output and changes the output wavelength spectrum. Coherence and far-field patterns are changed for all lasers if the input power is increased after irradiation to keep output power constant, and heating seems to be a more important cause of these changes than any direct effects of irradiation. (auth)

14922 (SCL-CR-66-154) EVALUATION OF FILAMENT WOUND EPOXY COMPOSITES. Final Report. Bowden, W. J.; Drayer, D. W. (Bendix Corp., Kansas City, Mo.). Feb. 1967. Contract AT(29-1)-789. 80p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For Sandia Corp., Livermore, Calif.

Nondestructive measurement techniques for determination of the internal composition of filament-wound fiberglass/epoxy panels were investigated. The techniques evaluated included: microwave analysis for glass-resin content; ultrasonic detection of porosity and voids; and beta backscatter for glass content. By use of the microwave analysis technique, a correlation was established between glass content (by weight) and voltage null points. In a second test method [investigated as part of the first technique], the correlation of data was insufficient to state that dielectric constant could be used as a measure of glass content. Analysis of the second technique disclosed a correlation between ultrasonic attenuation and porosity. This correlation was found to be closely related to the uniformity of the test sample material. The best sensitivity for detecting discrete voids was found to be a collimated beam of ultrasound in a through transmission technique. Beta backscatter appeared to be a practical method for determining glass content. There were several advantages to this technique and one possible disadvantage. The advantages concerned the simplicity of test setup and the means of contacting the test samples. The disadvantage concerned inspection depth versus part density. (auth)

14923 (SC-TM-66-2625) EVALUATION OF THE EFFECTS OF TRANSIENT RADIATION ON CAPACITORS. Coppage, F. N. (Sandia Corp., Albuquerque, N. Mex.). Dec. 1966. Contract AT(29-1)-789. 17p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Numerous studies showed that when a properly prepared sample (capacitor) is exposed to nuclear radiation, the primary consideration is the increased dielectric leakage current, which results from the creation of charge carriers within the material. This radioinduced conductivity (or photoconductivity) consists of the prompt component, which is coincident with the incident radiation, and the delay or long-lived component, which persists following the exposure. Both components for some materials were characterized as a function of temperature for pulsed radiation excitation. Results of studies of the effectiveness of neutrons in producing photoconductivity (as compared to gamma rays on an absorbed energy basis) showed that γ radiation is more effective than neutrons. The behavior of many dielectric materials, both organic and inorganic, was characterized. It is felt that the RC time constant for the capacitor equivalent circuit during exposure is a much more descriptive figure of merit for comparing dielectric materials than the values of A and δ alone. (auth)

PHYSICS (GENERAL)

Astrophysics

Refer also to abstracts 14979, 15027, 15134, 15171, 15237, and 15391.

14924 (N-66-36065) PROPAGATION OF LOW ENERGY CHARGED PARTICLES IN THE INNER SOLAR SYSTEM. Balasubrahmanyan, V. K.; Skadron, G. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Aug. 1966. 41p. (NASA-TM-X-57880). CFSTI $3.00 cy, $0.65 mn.

The effects of particle drift, diffusion, and convection are used to describe the propagation of solar charged particles in the inner solar system. It is found that protons and electrons gradient drift in opposite polar directions in the interplanetary magnetic field; and although the charge separation thereby produced is very small, this drift determines the energy loss of these particles. In addition, it is shown that electric field drift causes protons and electrons, alike, to corotate but slower than the magnetic field structure. As a result, solar particles injected onto a given magnetic field line sweep past the earth later than the field line. The resulting azimuthal intensity profile is determined by the distribution of sun-earth transit times for these particles as they diffuse along the magnetic field lines. These considerations are applied to low energy protons and electrons and predictions for their energy loss and intensity profiles are made. A comparison of these predictions with the data from the Imp 1 satellite indicates that the observed recurrent protons might be understood in terms of this analysis if the diffusion is sufficiently slow to give 1 MeV protons a 4 day transit time. The observed electrons, however, cannot have had such a solar origin and are evidently galactic. (auth)

14925 (N-66-36324) PROBABILITIES OF SOLAR FLARE OCCURRENCE. Roberts, William T. (National Aeronautics and Space Administration, Huntsville, Ala. George C. Marshall Space Flight Center). May 18, 1966. 20p. (NASA-TM-X-53463). CFSTI $3.00 cy, $0.65 mn.

The primary interest vehicle designers and advanced mission planners have in solar flares is the probability of occurrence of a damaging flare. Obviously then, one must define exactly what is a damaging flare. An environmental model of a "typical" flare is constructed herein, and the probability of occurrence of this or a similar flare is considered. The next step is to then derive an "extreme" model solar flare so that the effects of such a flare on occupants of a nominally shielded vehicle may be derived. Since it is intended to present only the environmental model, no attempt has been made to estimate the dose accrued for either type flare nor have any shielding calculations been performed. (auth)

14926 (N-66-37158) ANALYSIS OF F AND G SUBDWARFS. I. THE LOCATION OF SUBDWARFS IN THE THEORETICAL H-R DIAGRAM. Strom, S. E.; Cohen, J. G.; Strom, K. M. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). July 1966. 33p. CFSTI $3.00 cy, $0.65 mn.

Spectrum scans and model stellar atmospheres were used to locate in the (L/L_{sun}, T_{eff}) plane F and G subdwarfs having known parallax. A comparison is made between their position on the H-R diagram and the evolutionary tracks for population-II models of low- and high-helium content recently computed. The lower helium-content models are found to give somewhat more plausible ages than the high-helium models. (auth)

14927 (N-67-10871) THE UPPER LIMIT SOLAR GAMMA-RAY SPECTRUM TO 10 MeV. Peterson, Laurence E.; Schwartz, Daniel A.; Pelling, R. M.; McKenzie, David (California Univ., La Jolla, San Diego. Dept. of Physics). Aug. 18, 1966. Contract NAS5-3177. 11p. (NASA-CR-79715). CFSTI $3.00 cy, $0.65 mn.

Data obtained in part from a balloon flight series are compiled to form a composite upper limit gamma-ray spectrum from the quiet sun over the 20-keV to 10-MeV range. This is about a factor of thirty below previous observations from the OSO-I. Observations in the lower energy range were obtained with the prototype version of an x-ray detector originally designed for an OSO satellite; this consists of a 3-mm-thick x 10-cm^2-area NaI scintillation counter with an anticoincidence collimating shield of CsI. Results in the 1- to 10-MeV range were obtained using a 3" x 3" NaI scintillation counter, which has an omnidirection geometry factor of 67 cm^2 and nearly an isotopic response. This was flown at 126,000 feet during a night-day flight, with the solar flux obtained from the diurnal variation of counting rates. Measurements and estimates on the quiet sun gamma-ray spectrum are depicted; it is shown that the hot solar corona produces a steep free-free emission spectrum, which must join smoothly onto the estimated albedo flux due to cosmic ray interactions in the solar surface. Background fluxes and solar upper limits are tabulated. (STAR)

14928 (NASA-TM-X-47969) PUBLICATIONS OF GODDARD SPACE FLIGHT CENTER, 1964. VOLUME I. SPACE SCIENCES. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). 1354p.

Includes Reports, N-66-37946 through N-66-37973.

Articles, papers, talks, and reports generated by the scientific and engineering staff of Goddard Space Flight Center in the year 1964 were collected and are issued in two volumes. In this volume, the documents are grouped into the following subject categories: astronomy and astrophysics, celestial mechanics and geodesy, solar physics, ionosphere and radio physics, fields and particles, planetology, and planetary atmospheres. (For Volume II see NASA-TM-X-57970). (J.H.M.)

14929 (NASA-TM-X-57970) PUBLICATIONS OF GODDARD SPACE FLIGHT CENTER, 1964. VOLUME II. SPACE TECHNOLOGY. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). 1184p.

Includes Reports, N-66-37974 through N-66-37992.

Articles, papers, talks, and reports generated by the scientific and engineering staff of Goddard Space Flight Center in the year 1964 were collected and are issued in two volumes. In this volume, the documents are grouped into the following subject categories: space dynamics and control systems, spacecraft and subsystems, sensors, general electronics, environmental testing, tracking systems, and orbit determination. (For Volume I see NASA-TM-X-57969). (J.H.M.)

14930 (ORO-3235-12) NUCLEAR AND COSMOCHEMISTRY ANNUAL PROGRESS REPORT. Kuroda, P. K. (Arkansas Univ., Fayetteville. Dept. of Chemistry). Jan. 31, 1967. Contract AT(40-1)-3235. 51p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments are reported for studies on: nucleosynthesis models; fission; nuclear spectroscopy and decay schemes; cosmic-ray-induced nuclear reactions; geo- and cosmo-chemistry; and hot atom chemistry. (P.C.H.)

14931 GRAVITATIONAL RADIATION AND THE ARROW OF TIME IN COSMOLOGY. Rao, J. Krishna; Vaidya, P. C. (Gujarat Univ., Ahmedabad, India). Ann. Inst. Henri Poincare, Sect. A, 5: 77-81(1966).

The propagation of type-N gravitational radiation in steady-state and Einstein-de Sitter cosmologies is considered. It is shown that full retarded solutions are consistent in steady-state cosmology and full advanced solutions in Einstein-de Sitter cosmology. Full advanced solutions are not consistent in the former and full retarded solutions in the latter. (auth)

14932 QUASARS AND QUASISTELLAR GALAXIES CANNOT DIFFERENTIATE BETWEEN THE MODELS OF THE UNIVERSE. Lequeux, James (Faculte des Sciences, Paris). Sci. Progr.-Nature, No. 3381, 1-7(Jan. 1967). (In French).

The results of recent optical and radioelectric observations are reviewed. The hypotheses advanced to explain the nature of the quasistellar sources are reviewed and compared with the observations made. In spite of various hyphotheses advanced it is still believed that the spectral displacement of the quasistellar galaxies is due to the expansion of the universe and that these are very remote objects. The significance of the quasistellar galaxies and of quasars to the formulation of a cosmological theory is discussed. It is concluded that in spite of considerable progress accomplished in the study of these radiosources, theoreticians are no nearer a valid cosmological theory than before their discovery. (J.S.R.)

14933 SEARCH FOR 21-CENTIMETER RADIATION NEAR COSMIC X-RAY SOURCES. Hobbs, R. W.; Hollinger, J. P. (Naval Research Lab., Washington, D. C.). Science, 155: 448-9 (Jan. 27, 1967).

A search was made for 21-centimeter wavelength radiation in the regions of seven of the cosmic x-ray sources. No new sources with flux densities greater than 5.5 flux units were found. (auth)

14934 OBSERVATIONS OF ENERGY SPECTRA OF GALACTIC X RAYS. Hayakawa, Satio; Matsuoka, Masaru; Yamashita, Koujun (Univ. of Nagoya, Japan). Rep. Ionosphere Space Res. Jap., 20: 480-500(1966).

The energy spectra of galactic x rays were measured by means of four rockets named as L-3-3, K-9M-12, L-3H-1 and K-9M-15, launched in a year from March 1965, to March 1966. Scintillation counters borne on L-3-3 and L-3H-1 gave the energy spectra of galactic isotropic x rays and atmospheric ones in the energy range

5 keV to 40 keV. The differential spectrum of the former can be expressed by a power law as $E^{-(1.7\pm0.4)}dE$ or by the thermal radiation of temperature of $(1.9 \pm 0.4) \times 10^{8}$°K. The energy spectra of Sco X-1 and x-ray sources in Cygnus in the energy 2 to 20 keV were measured with proportional counters carried on K-9M-12. The energy spectrum of x-ray sources in Cygnus in the energy range 5 to 40 keV was also obtained with scintillation counters borne on L-3H-1. The energy spectra of Tau X-1 in the energy ranges 1 to 6 keV and 5 to 40 keV were measured with a set of G–M counters borne on K-9M-15 and with scintillation counters borne on L-3H-1 respectively. The energy spectrum of Sco X-1 is expressed as exp (–E/T)dE/E with $T = (3.8 \pm 0.3) \times 10^{7}$°K, whereas that of Tau X-1 as $E^{-(2.8\pm1)}dE$ and that of Cygnus sources as $E^{-(1.8\pm0.5)}dE$. (auth)

14935 SUGGESTED IDENTIFICATIONS FOR WEAK EXTRAGALACTIC RADIO SOURCES BETWEEN DECLINATIONS 0° AND –20°. Bolton, J. G.; Ekers, Jennifer (CSIRO, Chippendale, New South Wales). Austral. J. Phys., 20: 109-15(Feb. 1967).

Sixty-eight identifications are suggested from inspection of the Palomar Sky Survey prints in the positions of 262 weak radio sources between declinations 0° and –20°. Forty-seven of the suggested identifications are galaxies and 21 possible quasi-stellar objects. (auth)

14936 GRAVITATIONAL COLLAPSE AND CAUSALITY. Israel, W. (Dublin Inst. for Advanced Studies). Phys. Rev., 153: 1388-93(Jan. 25, 1967).

The relativistic dynamics of a thin spherical shell of dust collapsing under its own weight is developed on the hypothesis that the shell rebounds elastically after imploding to a point. The resulting description involves certain causal anomalies. The question of whether these anomalies can lead to actual logical contradictions is investigated. Possible similarities between the results obtained for the special case considered here and the characteristics of general asymmetric collapse are discussed. Reasons are given for believing (i) that singularities do not arise in the course of an asymmetric collapse except in special cases; (ii) that collapse of a mass M does not proceed irreversibly to zero volume, but is an oscillatory phenomenon in which the object never becomes smaller than a critical linear size of order GM/c^2; (iii) that when the object is near this critical size, a region develops in its interior where past and future cannot be globally distinguished; and (iv) that since the law of baryon conservation cannot be globally valid in such a pathological region, large-scale annihilation of baryons is possible. (auth)

14937 SYNCHROTRON RADIATION OF NEUTRINOS AND ITS ASTROPHYSICAL SIGNIFICANCE. Landstreet, John Darlington (Columbia Univ., New York). Phys. Rev., 153: 1372-7 (Jan. 25, 1967).

The neutrino-radiation from a completely relativistic electron gas in the presence of a large magnetic field (the neutrino analog of electromagnetic synchrotron radiation) is computed approximately, under the assumption of a direct electron-neutrino interaction. The radiation is also estimated in the case of a nonrelativistic electron gas. It is shown that the radiation increases strongly with electron energy and magnetic-field strength, and is therefore most likely to have astrophysical significance in the evolution of stars with large electron energies and potentially large magnetic fields, such as white dwarfs. However, computation of the total neutrino luminosity of several model white dwarfs shows that the neutrino luminosity is limited by electron degeneracy to values much less than the photon luminosity. The process is also found to be relatively unimportant in the evolution of neutron stars. (auth)

14938 ON THE LARGE-SCALE STRUCTURE OF THE SUN'S MAGNETIC FIELDS DURING THE DECLINING AND MINIMUM PHASES OF THE SOLAR ACTIVITY CYCLES. Sakurai, Kunitomo (Kyoto Univ.). Rep. Ionosphere Space Res. Jap., 20: 501-14(1966).

There are two active regions on the solar surface during the declining and minimum phases of the solar activity cycle. The positions of such active regions are separated by about 180 degrees in heliographic longitude and correspond closely with the distribution of magnetic fields on the low-latitude zones of the sun. As was discovered recently, the magnetic fields on the low-latitude zones of the sun are responsible for the creation of the interplanetary magnetic fields. Further, there is the "general" magnetic field on the sun, which is always observed on the sun's polar latitudes. The polarity of this field is reversed during the maximum phase of the solar activity cycle, but is maintained stable in the other phases. The structure of the magnetic fields in the low-latitude zones of the sun and its connection with the interplanetary magnetic fields are examined, based on the results observed recently by space probes. The effect of the sun's magnetic fields on the solar winds is estimated. The extent of the contribution of the sun's "general" and sunspot magnetic fields to the formation of the interplanetary magnetic fields is estimated dynamically. As a consequence, the structure and origin of the interplanetary magnetic fields is established. The reverse mechanism of the sun's "general" magnetic field and the formation of the magnetic fields in the low-latitude zones of the sun are discussed qualitatively on the basis of the electrodynamical consideration of the solar corona. The cause of the solar magnetic activity cycle is also discussed. (auth)

14939 ROLE OF ELECTRIC FIELDS FOR THE ACCELERATION OF ENERGETIC PARTICLES IN SOLAR FLARES. Sakurai, Kunitomo (Kyoto Univ.). Rep. Ionosphere Space Res. Jap., 20: 515-27(1966).

Energetic events such as the generation of solar cosmic rays and solar radio bursts frequently accompany great solar flares. Solar flares are triggered by rapid space–time changes of sunspot magnetic fields lying in the flare regions. High-energy particles can be produced through these changes. At present, the acceleration mechanism of these particles is believed to be due mainly to the space–time variation of sunspot magnetic fields. However, there is another possibility for the acceleration, namely, the importance of some electric fields on the acceleration of energetic electrons. This is pointed out by examining both the generation of electric fields and the efficiency of acceleration in the solar corona. The electric fields due to electron–plasma and ion–acoustic waves associated with the variation of sunspot magnetic fields may be especially important. These electric fields seem to play a main role in the acceleration of electrons during the explosive phase of solar flares. (auth)

14940 PROGNOSES OF GEOMAGNETIC ACTIVITY AND COSMIC RESEARCH. Halenka, Jaroslav (Geophysical Inst., Prague). Stud. Geophys. Geod., 11: 101-5(1967).

Long-term research into the influence of solar activity on geomagnetic activity has given a number of results explaining the nature of the sources of geomagnetic activity. These results were used in elaborating a method of forecasting of geomagnetic activity. The possibility is considered of extending the forecasting to the occurrence of streams of lower-energy solar particles in the extraterrestrial region of the planetary system. (W.D.M.)

14941 CLUSTERING OF THE COSMIC-RAY AGES OF STONE METEORITES. Tanenbaum, Andrew S. (Univ. of California, Berkeley). Earth Planet. Sci. Lett., 2: 33-5(Jan. 1967).

A statistical analysis of the distribution of cosmic-ray ages of stone meteorites indicates that significant discrete breakups probably need not be invoked to explain the apparent clustering of the hypersthene chondrites' ages. The clustering of the bronzite chondrites around 4 million years is not statistical. (auth)

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Refer also to abstracts 15236, 15247, and 15376.

14942 (ANL–7029, pp 9-12) ATOMIC-BEAM STUDIES. Childs, William; Dalman, John; Goodman, Leonard (Argonne National Lab., Ill.).

All data obtained with the Mark II atomic-beam magnetic-resonance apparatus since the last summary report are summarized. New values of electronic g factors, and of magnetic-dipole and electric-quadrupole hyperfine-interaction constants are presented for a number of low-lying atomic levels of various isotopes of Ni, Cr, Mn, Ge, Fe, and V. The use of a swept rf signal in coordination with a multichannel analyzer for data gathering is discussed. (auth)

14943 (CONF-660221–, pp 176) MEASUREMENT OF ELECTRON–ELECTRON SCATTERING CROSS-SECTION USING A TRANSVERSE BETA-RAY SPECTROMETER. Bhatanagar, K. G.; Bhawalkar, D. V.; Bhiday, M. R.

Electron–electron scattering cross sections were measured using ^{137}Cs beta rays that were energy selected within ±5% by a velocity selector placed in a combined electric and magnetic field. The electrons were scattered from a melinex foil mounted at the end of the velocity selector and were detected in coincidence using scintillation counters. The results, after various corrections, were compared with theoretical values calculated from the relativistic Rutherford, relativistic Mott, and Moeller cross sections. (D.C.W.)

14944 (CONF-660221–, pp 265-7) MEASUREMENT OF THE PHOTOELECTRIC CROSS SECTION OF LEAD FOR ^{54}Mn PHOTONS. Dasgupta, A.; Nath, A.; Ghose, A. M. (Bose Inst., Calcutta (India)).

The photoelectric absorption cross section of Pb for ^{54}Mn (0.84-MeV) photons was measured using the sphere transmission method. (D.C.W.)

14945 (CONF-660221–, pp 260-4) EMPIRICAL FORMULA FOR THE COHERENT SCATTERING CROSS SECTION OF GAMMA RAYS. Nath, A.; Ghose, A. M. (Bose Inst., Calcutta (India)).

An expression for the Rayleigh scattering cross section as a function of momentum transfer, gamma energy, and Z is presented and is compared with experimental results for Cu, Pb, and Sn. (D.C.W.)

14946 (ISS–66/31) CONSIDERAZIONI SULLA REAZIONE (e,e'γ). (Concerning the Reaction (e,e'γ)). De Sanctis, E. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Sept. 15, 1966. 46p. (In Italian). Dep. mn.

The usefulness of the study of the inelastic scattering reaction (e,e'γ) in which the scattered electron and the emitted γ are detected in coincidence is examined, in particular, the angular correlation function (e'−γ) is obtained assuming that the process can be divided into two independent steps, i.e., the electromagnetic electron–nucleus interaction and the nucleus de-excitation. (auth)

14947 (N–66-37276) INVESTIGATION OF ENERGY LEVELS IN FOIL EXCITED ATOMIC BEAMS. Semiannual Status Report, February 1–July 31, 1966. Chupp, E. L.; Dotchin, L. W. (New Hampshire Univ., Durham. Dept. of Physics). Aug. 29, 1966. 14p. (NASA-CR–78153). CFSTI $3.00 cy, $0.65 mn.

In experiments with the foil method of excitation on the relative population and mean lifetimes of some levels in atomic beams of hydrogen and helium, the fall-off in intensity of several spectral lines was measured as a function of time from the point of initial state population. The lines investigated were the 4861 Å and 1215 Å lines of H(I), and the 4859 Å, 3889 Å, and 4686 Å lines of He(I) and He(II). Problems connected with data analyses are discussed; it was found that, in preliminary analysis of Lyman α data, the best fit to the data is at least the sum of two exponentials. (STAR)

14948 (N–66-35962) STUDY OF INELASTIC ELECTRON-MOLECULE COLLISIONS. Progress Report No. 1, March 21–June 30, 1966. (Radio Corp. of America, Princeton, N. J. RCA Labs.). Contract NAS5-9303. 14p. (NASA-CR–77765). CFSTI $3.00 cy, $0.65 mn.

A summary is presented of the theory being applied to the calculation of the rate of dissociative recombination of N_2^+ and to be applied to the ion O_2^+. Partial results pertaining to N_2^+ are included. A study directed toward improvement of existing methods of calculating electronic transitions to continuum states of the nuclear motion is discussed. (auth)

14949 (NP–16370) IOONBRONNE VIR DIE PRODUKSIE VAN GEPOLARISEERDE PROTONE OF DEUTERONE. (Ion Source for Production of Polarized Protons and Deuterons). du Toit, Z. B. (Stellenbosch Univ. (South Africa). Merensky Instituut vir Fisika). Dec. 1964. 69p. (In Afrikaans). Dep. mn.

Thesis.

The characteristics of sources used for producing polarized protons and deuterons are critically examined, reviewing the theory of the methods involved in the ion production, and specifying the practical requirements. All of the currently operating and partially completed sources are tabulated. It is concluded that it is possible to construct a source of polarized protons or deuterons which yields a polarized ion current of 0.1 μA with a polarization of about 0.9; this value is 10^5 times higher than the intensity available from scattering. However, difficulties arise when such a source is used in an accelerator, because the source often must be exposed to a strong magnetic field or to high voltage. The source developed by Thirion at Saclay, which gives a high polarization, good intensity, and adjustable tensor polarization for deuterons, appears to be the most promising one. This source may be used in many types of accelerators. (TTT)

14950 (ORO–2591-22) LISTING OF AVAILABLE EXPERIMENTAL DATA ON THE FORMATION AND DESTRUCTION OF EXCITED STATES BY COLLISIONS BETWEEN ATOMIC SYSTEMS. Technical Report No. 1. Thomas, E. W. (Georgia Inst. of Tech., Atlanta. School of Physics). Oct. 30, 1966. Contract AT(40-1)-2591. 43p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A listing has been made of the sources of experimental data concerning the formation and destruction of excited states by atom-atom and ion-atom collisions. All processes occurring at impact energies less than 10 eV have been excluded. The listing is in five sections, each of which includes tabulations of reactants, range of impact energy, assessment of data accuracy and references. The five separate sections are as follows: (1) The formation of excited states by the collision of two ground state atomic structures under single collision conditions. Such data will in general be expressed in the form of cross sections either on an absolute or relative basis. (2) Differential inelastic scattering with the formation of an excited state, by the collision of two atomic structures under single collision conditions. Such data will in general be expressed in the form of a cross section. (3) Collisional quenching of excited states under single collision conditions. Such data will in general be expressed in the form of cross sections, either on an absolute or relative basis. (4) The formation of excited states in beams of particles passing through a gas or plasma, under multiple collision conditions. Such data can only be expressed in the form of the relative population of various states in the emergent beam. (5) The formation of excited states in beams of particles passing through a solid target, under multiple collision conditions. Such data can only be expressed in the form of the relative population of various states in the emergent beam. (M.O.W.)

14951 (ORO–2591-23) EMISSION AND EXCITATION CROSS SECTIONS. Progress Report No. 2, December 1, 1965–November 30, 1966. Thomas, E. W.; Bent, G. D.; Edwards, J. L. (Georgia Inst. of Tech., Atlanta. School of Physics). Dec. 1, 1966. Contract AT(40-1)-2591. 76p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The equipment for investigating the formation of excited states in a gaseous target is briefly described. Excitation cross sections were measured for proton impact on a helium target for each of the ^1S, ^1P, and ^1D levels. Measurements were also made on a single line emitted from the helium ion. Cross sections for excitation of the He target by H^+, H_2^+, and H_3^+ ions are also described. Proton excitation cross section measurements were also made for nitrogen, oxygen, and argon. Proton energies ranged from 0.15 to 1 MeV. (M.O.W.)

14952 (SC-R–67-1038) ELECTRON EMISSION FROM TUNGSTEN UNDER PROTON BOMBARDMENT: EFFECT OF NITROGEN ADSORPTION. Ewing, Ronald I. (Sandia Corp., Albuquerque, N. Mex.). Jan. 1967. Contract AT(29-1)-789. 12p. (CONF-758–64). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From American Physical Society Meeting, New York, Jan. 1965.

The yield of electrons emitted from polycrystalline tungsten under bombardment by 100-keV protons is found to depend upon the coverage of the surface by adsorbed nitrogen gas. The tungsten surface was cleaned by the flash-filament method and the yield measured as nitrogen gas adsorbed on the surface to a coverage of about 1.1 layers. The monolayer coverage time was varied from 9.0 minutes to 1.3 minutes by controlling the pressure of the nitrogen gas in the system. The yield increased with increasing surface coverage to about one monolayer, at which the increase over the value for a clean surface was 3.5%. Further adsorption of nitrogen caused the yield to decrease even below the clean surface value. (auth)

14953 (TDCK–44741) INFRARED: AN ANNOTATED BIBLIOGRAPHY UP TO 1966. Lieffering, H. (comp.) (Wetenschappelijk en Technisch Documentatie- en Informatiecentrum voor de Krijgsmacht, The Hague (Netherlands)). Mar. 1966. 160p. Dep. mn.

Included are abstracts of 426 papers on various aspects of infrared radiation. Nine chapters are arranged as follows: general, emission, transmission, detection, noise, systems, applications, miscellaneous, and bibliographies. (M.O.W.)

14954 ENERGY SPECTRUM OF CHANNELED PARTICLES. von Jan, R. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Rev. Lett., 18: 303-5(Feb. 27, 1967).

The shape and the angular dependence of the energy spectrum in a beam of channeled particles is discussed in terms of the distribution of the oscillation amplitudes. (auth)

14955 IONIZATION OF ATOMS IN A VARYING ELECTRIC FIELD. III. Perelomov, A. M.; Popov, V. S. Zh. Eksp. Teor. Fiz., 52: 514-26(Feb. 1967). (In Russian).

The quasiclassical approximation in the problem of traversal of a time-varying potential barrier by a particle is developed further. The effect of higher harmonics of a light-wave field on the ionization probability is considered and formulas for the Coulomb correction in the case of not-very-high frequencies are derived by means of the method. The physical meaning of the parameter γ_c and the possibility of taking into account coulomb interaction for $\gamma \gtrsim \gamma_c$ are also considered. (auth)

14956 ATOMIC BEAM IONIZER AS A SOURCE OF POLARIZED IONS. Ekhichev, O. I.; Zinchenko, G. N.; Zinchenko, N. S.; Karnaukhov, I. M.; Slabospitskii, R. P.; Taranov, A. Ya. Zh. Tekh. Fiz., 36: 1681-4(Sept. 1966). (In Russian).

An ionizer based on the principle of ion focusing as developed and patented earlier by Zinchenko and others, is described in some detail. In this arrangement, the electron beam is coaxial with, instead of perpendicular to, the beam of polarized atoms, thus increasing the ionization length. The electron beam was produced by an electron gun with an oxide cathode 5.5 and 9.6 mm in inner and outer diameter, respectively. The distance from the

cathode to the anode was about 7 mm, and from the anode to the collector, 60 mm. The hole diameters in the cathode, anode, and collector were 6, 7, and 8 mm, respectively. An investigation of the characteristics of the device revealed that the transmission factor of the electrons was 100% through the anode orifice, and 92% through the entire ionizer. The divergence of the electron beam was small, the beam diameter varying between 6 and 8 mm. A hydrogen atom beam produced by the dissociation of molecules in glow discharge and focused according to atomic spins in a field of a magnetic quadrupole was introduced into the ionizer. The measured efficiency of ionization was found to be 4.5×10^{-4} at a 90-mA electron current and a 1400-V potential difference between the cathode and anode. The mass-spectrometric data on the composition of the focused atomic beam showed that it consists of hydrogen atoms, thus confirming the stated efficiency of ionization. (ATD)

14957 COOLING OF THE FREE ELECTRONS OF A PLASMA. Gordiets, B. F.; Gudzenko, L. I.; Shelepin, L. A. (Lebedev Inst. of Physics, Moscow). Zh. Tekh. Fiz., 36: 1622-5(Sept. 1966). (In Russian).

A continuation is presented of four earlier papers by two of the authors, who showed that laser action was possible at optical, infrared, and ultraviolet frequencies when electrons of a highly ionized plasma with densities of 10^{14} to 10^{16} cm^{-3} were rapidly cooled from 20,000 to 1000°K. They now theoretically consider the cooling rates as a function of elastic collisions of free electrons with ions and neutral atoms and as a recombination of electrons at the cylinder walls. Their considerations are based on an electron model repeatedly heated and cooled by a pulsed electric field. The rapidly heated electrons generate a highly ionized, low-temperature plasma when the field is suddenly removed or the free electrons are cooled by collision of hot electrons with heavy cold atoms or ambipolar diffusion for 10^{-8} to 10^{-7} sec. Population inversion results which is sufficient to achieve laser action. The feasibility of developing a pulsed plasma laser in which simultaneous modulation of the heating electric field and the longitudinal magnetic field cause a highly ionized plasma during the heating cycle is discussed. (ATD)

14958 RESONANCE AND NUCLEAR RELAXATION IN THE LIQUID HEXAFLUORIDES OF Mo, W, AND U. Rigny, Paul; Demortier, Antoine (Department de Physicochimie, Saclay, France). Compt. Rend., Ser. B, 263: 1408-10(Dec. 19, 1966). (In French).

High-resolution spectra show the structure of regular octahedrals of MoF_6, WF_6, and UF_6 molecules in the liquid state. A study of the structure as a function of the frequency shows that in these liquids the relaxation is principally due to the spin–rotation interaction. (tr-auth)

14959 METHOD OF CALCULATING A BEAM OF INTERACTING PARTICLES. Moroz, E. M.; Solov'ev, N. S. (Lebedev Inst. of Physics, Moscow). Zh. Tekh. Fiz., 36: 1601-7(Sept. 1966). (In Russian).

A quadratic function approximating a universal curve for beams of a circular transverse cross section with a uniform cross-sectional distribution of particles is introduced. The basic relations characterizing the conditions for the optimal focusing of the beam and the conditions for conducting optimal current across two diaphragms are determined in analytic form. Formulas for determining the dimension and angular divergence of the beam at points inaccessible to direct measurement are derived; these formulas are based on the results of the measurement of the radii of beam cross section at two points. Thus, for an electron beam with kinetic energy of 800 keV, sufficiently accurate calculations can be assured at distances of $2y \lesssim 8$ m for current values of up to ~0.7 A and for current densities of up to ~1.5 A/cm^2; y is a particle coordinate of the nearest beam cross section point. (JPRS)

14960 SCATTERING OF MODERATE ENERGY IONS ON THE SURFACE OF A SOLID. Soszka, W. (Univ. Jagiellonskiego, Krakow). Postepy Fiz., 17: 627-45(1966). (In Polish).

The theory of scattering of moderate energy ions on the surface of a solid has been developed by E. S. Parilis. It has been shown that by means of Bohr's simple model of single and multiple collisions of unbound particles, and using the Firsov potential, one can explain the scattering phenomena, and in particular, the existence of fine structure of the energy spectrum of ions scattered on polycrystallic surfaces. The theory is in good agreement with the results of experimental papers. (auth)

14961 TRANSMISSION COEFFICIENT OF AN ELECTRON BEAM THROUGH A ONE-DIMENSIONAL FINITE CRYSTAL. Tanji, Michio (Fukushima Medical Coll., Japan). Sci. Rep. Tohoku Univ., 48: 151-65(July 1965).

The finite crystal, for which estimates are made of the transmission and reflection coefficients of an electron beam, is considered as a one-dimensional periodic potential field of finite length. Outside of the periodic field, constant potential field is assumed. Thus, transmission and reflection coefficients were calculated considering the potential energy of electrons in the crystal as square well type potential. The transmission coefficient, T, is affected by crystal thickness. T is sensitive depending upon thickness in the energy range of the so-called allowed band, which is defined for the infinitely extended crystal with cyclic boundary conditions. In the forbidden band, the energy range T decreases monotonously as the crystal becomes thicker. A numerical example is given. (BBB)

14962 MEASUREMENT OF SATURATION-INDUCED OPTICAL NONRECIPROCITY IN A RING LASER PLASMA. Lee, P. H.; Atwood, J. G. (Perkin Elmer Corp., Norwalk, Conn.). IEEE (Inst. Elec. Electron. Eng.), J. Quantum Electron., QE-2: 235-43(Aug. 1966).

In the experiments described, a ring laser was used to observe optical nonreciprocity in a gaseous laser active medium. When a gas laser plasma is illuminated by unequally intense laser beams traveling in opposing directions, its index of refraction becomes significantly nonreciprocal. This effect was examined by measuring the beat frequency between the counter-rotating beams in a 6328-Å He–Ne ring laser under controlled conditions. Frequency locking was effectively eliminated by using a Faraday effect beat frequency bias element. The measured beat frequency became a strong function of two independent parameters: the ring resonator tuning and the beam intensity difference. A second Faraday effect element was introduced to control nonreciprocal losses within the ring resonator. Servo loops controlling both the total laser intensity and the intensity ratio between the counter-rotating beams permitted direct measurement of the nonreciprocal gain caused by saturation, or hole burning. The effects observed are contained in Aronowitz theoretical description of ring lasers. It is concluded that in the use of ring lasers as rotation sensors, the magnitude of nonreciprocal dispersion effects could be a source of major error. For example, in the ring used, the nonreciprocity of transmittance would need to be maintained less than 10^{-7} to cause an error of less than 1 earth's rotation rate anywhere in the Doppler line. The experiment showed that there were environmental disturbances of nonreciprocal transmission much larger than this. Therefore, the performance of ring lasers as rotation sensors will be affected by how well errors caused by nonreciprocal dispersion can be controlled in practice. (BBB)

14963 BEHAVIOR OF SLOW ELECTRONS IN ATMOSPHERIC GASES. PART III. COLLISION CROSS SECTION OF MOLECULAR NITROGEN. Takayanagi, Kazuo (Tokyo Univ.); Takahashi, Tan. Rep. Ionosphere Space Res. Jap., 20: 357-73(1966).

Collision of an electron with an N_2 molecule, in the energy range from thermal region to 100 eV, is considered. The effective cross sections for all the important processes are brought together. The generalized oscillator strengths for some singlet–singlet transitions have been determined experimentally by Lassettre and his co-workers. Their data are used to calculate cross sections by the Born approximation. For excitation of triplet states, nothing can be done at present but collecting available experimental data. The ionization cross section of N_2 has been measured by several people in the past, but the energy distribution of ejected electrons has never been studied. The experimental photoionization cross section is used to derive an approximate energy distribution. For the vibrational excitation, the stopping cross section is calculated from experimental data of Schulz. Similarly, the stopping cross section for rotational transitions is obtained using revised theoretical values of Geltman and Takayanagi. (auth)

14964 FLUX OF BREMSSTRAHLUNG PHOTONS CAUSED BY ENERGETIC ELECTRONS PRECIPITATING INTO THE UPPER ATMOSPHERE. Kamiyama, Hiroshi (Tohoku Univ., Sendai). Rep. Ionosphere Space Res. Jap., 20: 374-94(1966).

Estimates are made of the emission of bremsstrahlung x rays caused by energetic electrons precipitating isotropically into the upper atmosphere. Taking account of the atmospheric absorption, which depends on the ray direction, the fluxes at various photon energies integrated over an upward and downward hemisphere are shown as a function of altitude for particular incident electron energies. In the region above about the 300-km level, in general, the upward fluxes are much more intense than the corresponding downward fluxes, and are almost constant. The spectrum of the photon flux is characterized by an incident electron energy and the atmospheric absorption, depending on the altitude at which the photon emission dominates. The rate of ionization produced through absorption of bremsstrahlung x rays in various photon energy ranges is shown as a function of altitude. The photoionization rate is found to be maximum at about 170 km for the incident electron energy, $E_0 = 1$ keV, at about 100 km for $E_0 = 10$ keV, and at about

55 km for E_0 = 100 keV. An additional description is given of the total effect of a flux of electrons having such a spectrum as that observed during an auroral display. (auth)

14965 PLURAL SCATTERING OF ELECTRONS AND POSITRONS. Braicovich, L.; De Michelis, B.; Fasana, A. (Politecnico, Milan). Phys. Rev., 154: 234-8(Feb. 10, 1967).

An experiment on the large-angle plural scattering of electrons and positrons in the energy range between 180 and 395 keV is presented. The experimental method is based on the study of the plural scattering effect on the transmission of thin gold foils (340 and 530 $\mu g/cm^2$). An approximate calculation of the large-angle plural scattering effect is also suggested, and the theoretical values agree satisfactorily with the results of the present experiment. (auth)

14966 MEASUREMENT OF THE ENERGY LOSS OF GERMANIUM ATOMS TO ELECTRONS IN GERMANIUM AT ENERGIES BELOW 100 keV. II. Chasman, C.; Jones, K. W.; Ristinen, R. A.; Sample, J. T. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. Phys. Rev., 154: 239-44(Feb. 10, 1967). (BNL-10470).

The amount of energy lost in the production of hole-electron pairs by germanium atoms stopping in a germanium crystal has been measured at energies of 56.2 and 102.9 keV. Inelastic neutron scattering in a Ge(Li) gamma-ray detector was used to produce the 690-keV ^{72}Ge state and the 596-keV ^{74}Ge state. The lines corresponding to the de-excitation of these states were broadened by summing with the hole-electron pairs produced by the recoiling Ge atom. A particular recoil energy was selected by requiring a coincidence with the outgoing inelastically scattered neutron, which was detected by a stilbene recoil counter placed at either 90° or 150° to the incident neutron beam. The results of the present experiment confirm a previous investigation by Chasman, Jones, and Ristinen and do not agree with the published results of Sattler, Vook, and Palms. (auth)

14967 CALCULATION OF THE CROSS SECTIONS FOR IONS OF THE LITHIUM ISOELECTRIC SERIES. I. TRANSITIONS OF THE DIPOLAR TYPE 2s → np. Bely, O. (Observatoire de Paris, Meudon, France). Ann. Astrophys., 29: 131-42(Mar.-Apr. 1966). (In French).

Cross sections were calculated for the permitted transitions of the type 2s → np, where n is between 2 and 7 for the ions Be II, N V, and Ne VIII, as well as for the transitions 2s → 3p and 2s → 7p in the limiting case of a lithium series ion of infinite charge. Coulomb-Born I or Coulomb-Born II approximations were used. The results were compared with the semiclassical impact parameter approximation as with the g approximations. Simple analytical forms were fitted to the computed cross sections. These parameters were extrapolated according to the levels n and to the different ions of the series. The tables and graphs which are provided make possible rapid determination of any 2s → np collision cross section for any ion of the lithium series. (BBb)

14968 EXCITATION OF HYDROGEN AND CaII UNDER CHROMOSPHERIC CONDITIONS. Giovanelli, R. G. (CSIRO, Chippendale, New South Wales). Austral. J. Phys., 20: 81-99 (Feb. 1967).

Methods are described for calculating excitation conditions in a hot gas in the absence of local thermodynamic equilibrium, taking self-absorption into account, in the approximation that excitation is uniform throughout the medium. The equilibrium excited-state populations and the emission, attenuation, and scattering properties derived from them are tabulated for a variety of physical conditions appropriate to the solar chromosphere ($7500 \leq T \leq 50{,}000°K$; $10^{10} \leq N_e \leq 10^{12}$ cm^{-3}) for some of the main spectral lines of hydrogen and Ca II. (auth)

14969 POSITRON LIFETIMES IN METALS. Weisberg, Howard; Berko, Stephan (Brandeis Univ., Waltham, Mass.). Phys. Rev., 154: 249-57(Feb. 10, 1967).

Positron decay curves in various metals have been measured, using careful sample preparation techniques and a delayed-coincidence system with 0.30-nsec (full width at half maximum) prompt time resolution and 10^4:1 peak-to-background ratio. Evidence was found that the annihilation in pure metals under ideal conditions is characterized by a single exponential decay, the second lifetime usually observed being an artifact of sample preparation. In thecase of Mg with ^{22}Na produced in situ by the (p,α) reaction, a single exponential decay over approximately four decades was observed. In a plot of annihilation rate versus conduction electron density, the observed rates for the nearly free-electron metals fell close to the theoretical curve of Kahana, approaching the spin-averaged positronium rate at low densities. Compared with these rates, annihilation rates at a given valence-electron density were found to be higher in the transition metals and lower in Be, Bi, and in the semiconductors Si and Ge, in agreement with qualitative ideas about the one-positron many-electron system in real metals. Within the experimental error (±2.5%), no difference in lifetime was observed between intrinsic and heavily n-type Si, and similarly for Ge. (auth)

14970 INFLUENCE OF AN INCREASING MAGNETIC FIELD ON A FREQUENCY-MULTIPLYING DEVICE IN AN ELECTROSTATIC MULTIPOLE FIELD. Linn, Hans-Jochen; Poeschl, Klaus; Veith, Werner (Siemens AG, Munich). Arch. Elek. Uebertrag., 20: 563-5(1966). (In German).

It is shown that in an electrostatic multipole field and a homogeneous magnetic field an electron beam initially modulated in the pattern of a synchronous wave contains harmonics of certain orders. These harmonics grow along the axis, possibly beyond the initial value of the first harmonic wave. Associated with this phenomenon is an ultimate rapid rise of the displacement of some electrons. This can be prevented by an increase in the longitudinal magnetic field along the axis. In this investigation of the electron motion in an octopole with linearly increasing magnetic fields, growing harmonics were also demonstrated. The possibility of a stable frequency-multiplying device with conversion gain is suggested. (BBB)

14971 TOTAL REFLECTION OF X-RAY RADIATION ON THE SURFACE OF SOLIDS. Hrdy, Jaromir. Cesk. Cas. Fys., 17: No. 1, 95-106(1967). (In Czech).

The total reflection of X-ray radiation is considered. The present state of the theory is described, including possible practical applications. Further, typical experimental methods and experimental work in this field are briefly reviewed. (auth)

14972 COLLISION CROSS SECTIONS OF H^- IN CO_2 AND N_2. Kovacs, Istvan. KFKI (Kozp. Fiz. Kut. Int.) Kozlem., 15: 37-48 (1967). (In Hungarian).

The collision cross sections of H^- for the loss of one and two electrons, respectively, have been measured in N_2 and CO_2 gases over the energy range from 200 to 500 keV by analyzing the beam on its exit from the collision chamber with respect to the three components. Over the covered range of energy the cross sections were observed to decrease monotonically with increasing ion energies. (auth)

14973 COLLISIONAL EXCITATION TRANSFER BETWEEN HYDROGEN ATOMS. I. H(2p) + H(1s) → H(1s) + H(2p). Nakamura, Hiroki; Matsuzawa, Michio (Tokyo Univ.). J. Phys. Soc. Jap., 22: 248-56(Jan. 1967).

The exact resonant process H*(2p) + H(1s) → H(1s) + H*(2p), of which the interaction is a typical long-range one, was investigated by the method of perturbed stationary state. The energy curves of the interaction of normal and excited hydrogen atoms necessary for the determination of the cross section were calculated by the Heitler-London procedure. The computations of the cross section were carried out at energies of relative motion 0.1, 1.0, 3.0, 5.0, and 10.0 eV. The results agree well with the corresponding calculations by the impact parameter method. At 0.1 eV the calculated cross section is 821 πa_0^2. (auth)

14974 ELECTRON CAPTURE BY POLAR MOLECULES. Levy-Leblond, Jean-Marc (Univ. of Rochester, N. Y.). Phys. Rev., 153: 1-4(Jan. 5, 1967).

It is shown that binding of electrons in the electric dipole field of polar molecules cannot possibly occur, if the molecules have an electric dipole moment smaller than the critical value $D_0 = 1.63 \times 10^{-18}$ esu cm, irrespective of the size of the dipole. This result casts doubts on a proposed mechanism of electron scattering by polar molecules, namely, electron capture with rotational excitation of the molecule. (auth)

14975 $6p^3(^4S)7s - 6p^3(^4S)np$ SERIES IN THE SPECTRUM OF Po I. Vernyi, E. A. Zh. Prikl. Spektrosk., Akad. Nauk BSSR, 5: 795-6(Dec. 1966). (In Russian).

Additional spectral classification of Po I has been carried out on the basis of the published experimental data. Twelve even configuration levels of $6p^3(^4S)np$ have been found, and the ionization energy value of a polonium atom has been defined more precisely. (auth)

14976 CHILLED COLLIMATOR FOR HIGH INTENSITY MOLECULAR BEAMS. Hundhausen, E.; Harrison, Halstead (Boeing Scientific Research Labs., Seattle). Rev. Sci. Instrum., 38: 131-2(Jan. 1967).

A collimator arrangement which permits extended operation of high intensity sources of condensable molecular or atomic beams is described. Construction notes and recent laboratory experience are described to supplement an earlier report of Laval nozzle performance with condensable beams. (B.G.D.)

14977 ION-ION RECOMBINATION COEFFICIENT. II. MEASUREMENTS IN OXYGEN-NITROGEN MIXTURES. McGo-

wan, S. (Defence Chemical, Biological and Radiation Labs., Ottawa). Can. J. Phys., 45: 439-48(Feb. 1967). (DCBRL-516).

Ion-ion recombination coefficients were measured at pressures ranging from 50 to 800 torr for four oxygen-nitrogen mixtures which had been passed through cold traps at temperatures just above the boiling points of the gas samples. The following values of α were obtained at 1 atm and 25°C: in O_2, $(2.00 \pm 0.10) \times 10^{-6}$ cm^3/sec; air, $(2.21 \pm 0.10) \times 10^{-6}$ cm^3/sec; N_2 with 1% O_2, $(2.24 \pm 0.10) \times 10^{-6}$ cm^3/sec; N_2 with 0.001% O_2, $(2.45 \pm 0.15) \times 10^{-6}$ cm^3/sec. The observed pressure dependence of α followed that predicted by Natanson's theory. Considerably lower values of about 1.6×10^{-6} cm^3/sec were found for untreated air, and a further reduction to about 1.4×10^{-6} cm^3/sec was observed when surfaces, which had been coated with a colloidal suspension of graphite in alcohol, were present. (auth)

14978 ION-ION RECOMBINATION COEFFICIENT. I. CORRECTION FOR ION DISTRIBUTION AND DIFFUSION LOSSES IN PLANE PARALLEL ION CHAMBERS. McGowan, S. (Defence Chemical, Biological and Radiation Labs., Ottawa). Can. J. Phys., 45: 429-37(Feb. 1967). (DCBRL-515).

Correction factors to measured values of the ion-ion recombination coefficient, which are required because of nonuniform ion density and diffusion losses, are calculated from computer solutions to the differential equation for simultaneous recombination and diffusion. Results for plane-parallel ion chambers are given as a function of ion age for an initially uniform ion distribution over a considerable range of ion density and electrode spacing, and for a collimated distribution for two particular combinations of ion density and electrode spacing. Corrections to be applied to some reported experimental ion-ion recombination coefficients are estimated. (auth)

14979 FRANCK-CONDON FACTORS AND r CENTROIDS FOR THE C → X BAND SYSTEM OF ZrO. Singh, P. D.; Pathak, A. N. (Univ. of Gorakhpur, India). Proc. Phys. Soc. (London), 90: 543-4(Feb. 1967).

The Franck-Condon factors $q_{v',v''}$ and r centroids $\bar{r}_{v',v''}$ are reported for the C $^1\Delta \rightarrow$ X $^1\Sigma$ band system of the astrophysically important zirconium oxide molecule. The r centroids increase with an increase in wavelength. The values of $\Delta\bar{r} \equiv \bar{r}_{v'+1,v''+1} - \bar{r}_{v',v''}$ are found to be constant for a given sequence. (auth)

14980 METASTABLE ATOMS IN FAST HELIUM BEAMS. Wittkower, A. B.; Levy, G.; Gilbody, H. B. (University Coll., London). Proc. Phys. Soc. (London), 90: 581-2(Feb. 1967).

The process of one-electron loss during the passage of fast helium atoms through gaseous targets was investigated. Apparent cross sections σ_{01} are shown to be dependent on the conditions of formation of the fast helium atoms. (auth)

14981 PHOTOIONIZATION OF Li^+. Bell, K. L.; Kingston, A. E. (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 90: 337-42(Feb. 1967).

The method of polarized orbitals is used to obtain a wave function for an electron in the field of a Li^{2+} ion. For low electron energies the polarized-orbital phase shifts are in reasonable agreement with extrapolated experimental quantum defects. The photoionization cross section for Li^+ is calculated in the dipole length and velocity formulations using the polarized-orbital wave function for the continuum state and six-parameter and twenty-parameter Hylleraas-type wave functions for the ground state. Oscillator strength sums suggest that the calculated cross sections are accurate to about 3.5%. A comparison of the present calculations with experimental data on metallic lithium show that absorption coefficients of Li^+ and metallic lithium are not equal. (auth)

14982 EXPERIMENTAL STUDY OF SMALL-ANGLE SCATTERING IN CHARGE-TRANSFER COLLISIONS. Wittkower, A. B.; Gilbody, H. B. (University Coll., London). Proc. Phys. Soc. (London), 90: 343-52(Feb. 1967).

Beams of H^+, He^+, Ne^+, Ar^+, and Kr^+ ions at energies between 60 keV and 250 keV were passed through various thin gas targets where fast neutral atoms were formed by electron capture. The small-angle scattering associated with such collisions was measured by scanning a particle detector across a diameter of the emergent beam. Differential electron capture scattering cross sections were measured in H_2, He, Ne, Ar, and Kr gases. (auth)

14983 CORRECTION OF SOME ERRONEOUS CALCULATIONS OF THE EINSTEIN A COEFFICIENT FOR THE 18cm. TRANSITION OF OH. Lide, D. R. (National Bureau of Standards, Washington, D. C.). Nature, 213: 694-5(Feb. 18, 1967).

There is confusion over the value of the Einstein A coefficient for the $^2\Pi_{\frac{1}{2}}$, $J = \frac{3}{2}$, Λ doublet transition of OH. This coefficient is required to derive the interstellar abundance of OH from the intensity of the OH absorption lines observed in radioastronomy. Calculation of the transition probability can most conveniently be done in two steps. First, the probability can be calculated for the pure Λ doublet transition without regard to hyperfine structure. Secondly, the effect of the hyperfine structure can be treated by well-known methods. These calculations are described and discussed, and errors in calculations by other authors are pointed out. The value obtained for the transition coefficient is 8.53×10^{-11} sec^{-1}. Values are also given for the Einstein coefficients for individual hyperfine components. (UK)

14984 HYDROGEN ISOTOPE DIFFUSION. Jones, P. M. S. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Nature, 213: 689-98(Feb. 18, 1967).

It is stated that hydrogen isotope diffusion in metals and polymers has generally been treated as a single-body problem, with motion of the hydrogen as the important parameter. The single-body approximation leads to the conclusion that the ratio D_H/D_D should have a value close to 1.4, as has been found in some strongly interacting metal-hydrogen systems, for example, Pd/H_2 and Zr/H_2. It was found, however, that for polymer systems and a number of metals, this is not the case. It is concluded that for these systems the motion of solute molecules or atoms in the solvent lattice is not rate controlling and that the diffusion rate is dependent on the solvent lattice itself. The motion of the lattice atoms will be much less than that for self-diffusion of solvent material and will depend on solute molecule size, which is nearly the same for hydrogen and deuterium. Whether lattice motion or hydrogen molecule or atom motion is rate controlling depends on a number of factors, such as temperature, solute-solvent interaction, and solvent material. Exothermic occluders such as Pd and Zr with strong hydrogen atom-metal interaction show large isotope effects with regard to diffusion coefficients. Interstitial diffusion with hydrogen atom transport as the rate controlling step applies for these systems. Some steels appear to be intermediate in behavior. (UK)

14985 VAINSHTEIN METHOD APPLIED TO ELECTRON IMPACT EXCITATION AND IONIZATION OF ATOMS. Omidvar, Kazem (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev. Lett., 18: 153-6(Jan. 30, 1967).

In most calculations on inelastic collision of electrons with atoms there has been a general lack of agreement with observation mainly due to the treatment of the interelectronic interactions as a perturbation. Vainshtein recently gave full account to this interaction by treating the problem as a binary collision between the incident and atomic electrons with the motion of their center of mass in the Coulomb field of the nucleus. Marked improvement in comparison of theory and observation has resulted. Three approximations applied in this calculation are described briefly. The integral involved in the third approximation is evaluated exactly, revealing new structure in the theory and obtaining overall improvement in comparison of theory and observation. (M.H.R.)

14986 STRUCTURE OF THE SPECTRUM OF NEUTRAL TERBIUM, Tb I. PART II. Klinkenberg, P. F. A.; Meinders, E. (Univ., Amsterdam). Physica, 32: 1617-32(Oct. 1966).

The term scheme of Tb I discussed previously (Physica, 32: 1113(1966)) is extended with 7 even and 36 odd levels, partly by making use of an electronic computer. For all even levels the g-factor was derived from Zeeman effect measurements. A list of 902 newly classified lines is given, whereby the total number is raised to 2240, accounted for by 19 low even levels and 332 odd levels. The even levels all belong to the configuration $4f^85d6s^2$ and they are arranged in multiplets. (auth)

14987 IONIZATION AND ELECTRON CAPTURE CROSS SECTIONS FOR PROTONS INCIDENT ON NOBLE AND DIATOMIC GASES BETWEEN 10 AND 140 keV. De Heer, F. J.; Schutten, J.; Moustafa, H. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Physica, 32: 1766-92(Oct. 1966).

Total ionization and electron capture cross sections were determined for protons incident on noble and diatomic gases between 10 and 140 keV. The apparatus used for these experiments is the same as used before for measurements on ionization by electrons. In that case the condenser method was applied with an axial magnetic field and detailed attention was paid to the elimination of disturbing effects caused by secondary electrons and to the influence of diffusion effects on the pressure measurements with a McLeod gauge. The ionization by protons is compared with that by electrons. For many cases the ionization and electron capture cross sections are in agreement with those obtained by other investigators. However, below about 30 keV there is very often a big difference in the ionization cross sections of different investigators. (auth)

14988 IONIZATION AND ELECTRON CAPTURE FOR HELIUM IONS INCIDENT ON NOBLE AND DIATOMIC GASES

BETWEEN 10 AND 140 keV. De Heer, F. J.; Schutten, J.; Moustafa, H. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Physica, 32: 1793-1807(Oct. 1966).

Ionization and electron capture were investigated for helium ions incident on noble and diatomic gases between 10 and 140 keV The cross section measurements form an extension of the work with proton projectiles and the apparatus used for these experiments is again the same as used before for the measurements on ionization by electrons. In that case the condenser method was used with an axial magnetic field. Because multiply charged ions can be formed and the fast helium ion itself can be ionized by the target atoms, the condenser method only provides total cross sections for apparent electron capture, slow ion production, and electron production. The results very often agree with those of other investigators, but there are also cases of big discrepancy. (auth)

14989 ANALYSES OF IONIZATION EFFICIENCY CURVES AND MULTIPLE IONIZATION PROCESSES. Shadoff, Lewis Allan. Manhattan, Kan., Kansas State Univ., 1966. 146p.

Thesis.

There is much information contained in ionization efficiency data (ion current as a function of electron energy). A computer program for the determination of appearance potentials of ions formed in a mass spectrometer by electron impact was devised based on two graphical techniques. The results from the use of this program were in excellent agreement with the values obtained by the graphical techniques applied to the same data and with the values reported in the literature. Using the kth-root law for the threshold region of electron impact ionization efficiency curves, the multiple ionization potentials for various atomic and molecular species were determined. This law also allows the determination of electronic transition probabilities for ionization by electron impact. The values of relative secondary electron emission coefficients (which are directly related to the sensitivities) determined on the time-of-flight mass spectrometer differed from those reported in the literature. Therefore, a mechanism for the formation of secondary electrons was formulated in order to account for the discrepancy. Using this mechanism, the values of relative secondary electron emission coefficients determined by the use of equations for Coulomb collisions agreed well with the experimental results, indicating the validity of the mechanism. It has been shown that the study of relative electronic transition probabilities is possible with the time-of-flight mass spectrometer by taking into account the secondary electron emission coefficients for multiply charged ions impacting on the ion cathode. The results tend to substantiate the validity of the threshold law for ionization. In an attempt to extend the capabilities of the time-of-flight mass spectrometer to the study of nonvolatile compounds (many of which have been shown to exhibit multiply charged ions upon electron impact), an ion source containing a heated sample chamber was constructed. This system was shown to be not only eminently suited to the study of nonvolatile compounds, but also for the study of the volatile products formed upon the thermal decomposition of nonvolatile compounds. (TSS)

14990 ^{14}C LABELED ION BEAMS FOR HOT ATOM CHEMISTRY. Blaxell, David; Maddock, A. G. (Cambridge Univ., Eng.). 22p. (CONF-660431-9). DTIE.

From Symposium on Hot Atom Chemistry, Lafayette, Ind.

The development of a high-intensity, reasonably monochromatic ion beam apparatus operating at a few kilovolts with subsequent deceleration to a few volts is described with particular reference to the more salient problems of ion production and beam control. Some preliminary observations from reactions of $^{14}C^+$ and $^{14}CO^+$ beams above 200 eV with solid benzene are reported. (auth)

14991 DISSOCIATION RATE OF ENERGETIC H_2^+ PASSING THROUGH A LITHIUM PLASMA. Bottiglioni, F.; Coutant, J.; Gadda, E. (EURATOM-CEA, Fontenay-aux-Roses, France). 4p. (CONF-651126-31). DTIE. Gmelin, AED-CONF-65-353-84a.

From American Physical Society, 7th Annual Meeting of the Division of Plasma Physics, San Francisco.

The duoplasmatron ion source is connected to the accelerating voltage, variable from 20 up to 50 kV. The extracting electrode is grounded. The beam is prefocused by an electrostatic decelerating–accelerating lens and, after passing through a water-cooled diaphragm, magnetically focused. The beam then passes through a magnetic channel and is injected into the middle plane of the vacuum chamber of the lithium arc. The magnetic field confining the discharge is adjusted to the beam energy so that, after a 90° deflection, the H_2^+ beam crosses the axis of the arc. Diagrams showing the dissociation processes are included. (M.O.W.)

Cosmic Radiation

Refer also to abstracts 14928, 15027, and 15524.

14992 (NP-16592) RESOURCE BIBLIOGRAPHY ON COSMIC RAYS AND RELATED SUBJECTS. Winckler, J. R.; Hofmann, D. J. (Minnesota Univ., Minneapolis. Cosmic Ray Group). Dec. 1966. 70p. (CR-89).

This compendium of material in the field of cosmic radiation and related subjects was assembled at the request of AIP to constitute the first resource letter on cosmic rays. The material was selected and indexed according to the established procedure for such resource letters and is grouped into categories such as important original research papers, books, review articles, conference proceedings, films, popular articles, etc. An edited version of the resource letter was published in American Journal of Physics, Vol. 35, January 1967. (W.D.M.)

14993 THE COSMIC-RAY NUCLEONIC COMPONENT IN THE ANTARCTIC ZONE. Cicchini, A. A.; Fritz, N. A. Simionati de (Escuela Superior Tecnica, Buenos Aires). Nuovo Cimento (10), 47A: 673-4(Feb. 1, 1967).

The results are reported of five series of investigations from December through March during the years 1959 through 1964 in which the cosmic-ray nucleonic component was recorded by means of a neutron monitor (IGY) installed on board of the General San Martin icebreaker, traveling from Buenos Aires (34°6′ S Geographical Latitude) up to Ellsworth (77°7′ S Geographical Latitude). Results are presented of the logarithm of the intensity as a function of vertical cutoff rigidity and the variation of its slope with solar activity. (L.B.S.)

14994 ATTEMPT AT DETERMINING THE RADIAL DISTRIBUTION OF MUONS OF EXTENSIVE AIR SHOWERS AT DISTANCES CLOSE TO THE AXIS. Bonczak, Bazyli; Gawin, Jerzy; Hibner, Juliusz (Inst. of Nuclear Research, Polish Academy of Sciences, Lodz). Nukleonika, 11: 791-7(1966).

Some 3000 extensive air showers were recorded. The individual localization of an axis, or rather, determination of the most probable area where the shower axis lies, is based on analysis of the number of times detectors are struck by charged particles and the number of times detectors are struck by particles of the penetrating component. After localization of the axes, an attempt may be made to determine the muon distribution. (B.G.D.)

14995 PRIMORDIAL RARE GASES IN UNEQUILIBRATED ORDINARY CHONDRITES. Heymann, Dieter; Mazor, Emanuel (Univ. of Chicago). Science, 155: 701-2(Feb. 10, 1967).

The primordial gases of eight unequilibrated ordinary chondrites are strongly fractionated with respect to "cosmic" proportions. The absolute amounts are roughly proportional to the degree of disequilibration. Apparently, ordinary chondrites originally contained considerably larger amounts of primordial rare gases. (auth)

14996 STUDIES ON X AGENT. L. FURTHER STUDIES ON DIURNAL FLUCTUATION OF X AGENT REVEALED IN ITS ACTION ON THE APPARENT TRANSPARENCY OF FROSTED GLASS SURFACES. Moriyama, Hideo (Shonan Hygiene Inst., Kamakura, Japan). Yokohama Med. Bull., 17: 157-64(Oct. 1966).

Transmittance of the frosted glass surfaces of an absorption cell for use with the Leitz photometer occasionally showed variations when placed beside water or lead. It is suggested that this is caused by the so-called secondary X agent emitted from the substance. The frosted glass is activated, it is proposed, by the secondary X agent and the light passing through such activated glass surfaces affects the photoelectric cell of the photometer by which the transmittance is being measured, resulting in an apparent change in transmittance. The diurnal variation of the transmittance change was investigated. When examined continually at intervals of 1 hr from early morning until night, the degree of the change was found to become greatest at about 10 A.M., disclosing a distinct diurnal fluctuation. Examination was performed with three absorption cells, one of which was placed in a metal box. The other two cells were left outside the box, one beside a bottle of water and the other far from the bottle, nothing being placed near it. The diurnal fluctuation was most marked in the cell in the metal box; the two cells outside the box showed almost no fluctuation of transmittance. All three cells frequently revealed a transient change in the morning and also in the evening. (BBB)

14997 TRANSITION OF EXTENSIVE AIR SHOWERS IN THE ATMOSPHERE. Ito, Nobuo (Osaka City Univ.). J. Phys. Soc. Jap., 22: 6-19(Jan. 1967).

The transition of extensive air shower (EAS) in the atmosphere had been estimated so far from the data of zenith angle distri-

bution, atmospheric pressure effect, etc., assuming that (a) the starting point of EAS is close to the top of the atmosphere, and that (b) the lateral distribution function of charged particles is unique for all EAS. As a result of the present experiment, it was concluded that (a) there are various cases of different lateral structure in observed EAS, (b) the interaction mean free path to build up the EAS is estimated as about 100 g/cm², and (c) the inelasticity in the high-energy nuclear interactions is estimated as high as about 0.7. The age parameter distribution of observed EAS suggests wide range distribution of EAS production level as well as various attenuation character for individual EAS. These problems are discussed and an experiment using water is proposed to make the above points clear. The preliminary results are also shown. (auth)

14998 INTRODUCTION OF METEOROLOGICAL CORRECTIONS INTO MESON MONITOR DATA. Carmichael, H.; Bercovitch, M.; Steljes, J. F. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Tellus, 19: 143-59(1967).

A set of regression calculations was carried out correlating the daily average meson intensity with barometric pressure, atmospheric temperature, and neutron monitor intensity. Two complete years of data from a plastic scintillator meson monitor and from a large neutron monitor, operated in a constant-temperature laboratory at Deep River, were used. An exhaustive list of atmospheric temperature parameters was investigated: ground temperature; the heights of the 100, 200, 300, and 400 mb isobaric levels; some recommended combinations of isobaric level heights and temperatures; formulations due to Dorman and to Maeda using temperatures at all the standard isobaric levels; a number of arbitrarily distorted versions of these formations including those recommended by Wada and by Lindgren. It was found that the formulations of Dorman, of Maeda, and of Wada were almost indistinguishable in terms of the available data and yielded by far the best fit among the variables. However, none of the temperature parameters tried was able to fit the day-to-day and the seasonal temperature effects equally well with a single regression coefficient. Use of the following partly empirical temperature parameter resolved the difficulty for routine correction of the Deep River data: $1.045\,T(j) + 0.215\,\overline{T}(j)$, where $T(j)$ is Maeda's temperature correction for day j and $\overline{T}(j)$ is its 31-day running average centered on day j. (auth)

Direct Energy Conversion

14999 (AD-641432) OPTIMUM ELECTRODE CAVITIES FOR THERMIONIC ENERGY CONVERTERS. Final Report, August 1, 1964-July 31, 1966. Rufeh, F.; Kitrilakis, S. S.; Lieb, D. (Thermo Electron Engineering Corp., Waltham, Mass.). Aug. 31, 1966. Contract AF 19(628)-4322. 89p. (AFCRL-66-683). CFSTI $3.00 cy, $0.65 mn.

The diffusion coefficient of cesium ions in cesium plasma and the reflection coefficient of the ions from the plasma boundaries were measured using a three-collector thermionic diode. Based on these transport parameters, a cavity-collector diode was designed and constructed. The experimental data from this system indicate that the ions generated in the cavities diffuse to the surrounding regions and neutralize the electron space charge. This result is important to thermionic conversion since it shows the possibility of reducing electron scattering and the internal voltage drop needed for volume ionization. (auth)

15000 PROBE-METHOD INVESTIGATION OF THE PLASMA IN THERMIONIC CONVERTERS WITH HIGH CESIUM PRESSURE. III. DISTRIBUTION OF THE CONCENTRATION, THE ELECTRON TEMPERATURE, AND THE SPACE POTENTIAL IN THE INTERELECTRODE GAP OF THERMIONIC CONVERTERS. Dyuzhev, G. A.; Baksht, F. G.; Martsinovskii, A. M.; Moizhes, B. Ya.; Pikus, G. E.; Yur'ev, V. G. Zh. Tekh. Fiz., 36: 1685-97(Sept. 1966). (In Russian).

Specially constructed instruments with movable probes were used in extensive investigations of the operation of a cesium-filled thermionic converter. The investigations were carried out at pressures characteristic of both the diffusion and arc modes. The measurements confirm the theory of the diffusion mode advanced in 1960 by Moizhes and Pikus. They also show that, at low cathode temperatures, the ionization starts in this mode next to the anode in the region of the anode drop. The transition to the arc mode is accompanied by a redistribution of the potential and a shifting of the ionization region toward the cathode. In the arc mode, a substantial part of the applied voltage drops on the near-cathode barrier and in the region close to the cathode. Next to the anode and in the anode region there is only a small potential barrier, which vanishes with increasing current. The electron temperature in the gap appears to be almost constant, although it increases slowly with increasing current. At the same time, the carrier concentration increases rapidly when current increases. The values of electron concentration and temperature obtained by the authors agree with those obtained by other researchers in spectral measurements. While they consider their method highly useful and accurate, the authors concede that, unlike optical methods, it does not yield information on the degree of equilibrium in the plasma. (ATD)

15001 MAGNETOHYDRODYNAMIC GENERATOR WITH LIQUID METAL. Nicolaide, Andrei (Institutul Politehnic, Brasov, Rumania). Electrotehnica, 14: 225-38(July 1966). (In Rumanian).

The theory of the MHD generator with liquid metal is explained. It has been found by studying the electromagnetic field in the machine that the effect of the reaction magnetic field leads to poor utilization of the MHD channel and to a low efficiency. Some calculus elements concerning this machine are also described. A new detailed study is devoted to the end effect of currents on the basis of the elliptical function theory. Some results unknown to the literature are obtained. (auth)

15002 THERMOEMISSION CHARACTERISTICS OF TRANSITION METALS AND THEIR COMPOUNDS. Samsonov, G. V.; Paderno, Yu. B.; Fomenko, V. S. (Inst. of Materials Science Problems, Academy of Sciences, Ukrainian SSR). pp 108-15 of Vysokotemperaturnye Neorganicheskie Soedineniya. Samsonov, G. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1965. (In Russian).

The work function was determined by a cathode electronic technique for all transition elements as well as for their silicides, borides, carbides, and nitrides. It was found that the work function increases with increasing occupation of the valence orbitals in the case of p elements and with increasing occupation of the d orbitals in the case of d elements. This dependence has maxima at p^3, d^{10}, p^3, and d^5. The work function of the compounds of transition elements was found to depend upon the ionization potential of the metalloid moiety of the compound. Intermetallic compounds exhibit generally lower work-function values than compounds involving nonmetals. The dependence of the work function of several elements and their compounds upon the atomic number of the elements and the dependence of the work function of transition elements and their compounds upon the degree of occupation of the d orbitals of the metal atoms are shown in figures. (ATD)

15003 THERMOELECTRONIC PROPERTIES OF $(UC)_{0\text{-}2}$:$(ZrC)_{0\text{-}8}$. Fedorus, A. G.; Marchuk, P. M. (Inst. of Physics, Academy of Sciences, Ukrainian SSR). pp 274-7 of Vysokotemperaturnye Neorganicheskie Soedineniya. Samsonov, G. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1965. (In Russian).

The thermoelectronic emission of UC and UC_2 and of a solid solution of U and ZrC $(UC)_{0.2}$:$(ZrC)_{0.8}$ was studied in vacuo and the thermoelectronic emission of $(UC)_{0.2}$:$(ZrC)_{0.8}$ solid solution was studied in the presence of Cs vapor. The temperature varied from 1620 to 2200°K and the Cs vapor pressure varied in a wide range (saturation pressures corresponding to 70 to 200°C). The experimental tube used is shown. The cathode thermoelectronic emission efficiency was calculated from the formula $\eta \approx P_M / (P + j_M \varphi)$ where P_M is the maximum specific output per cathode unit surface area, P is the intensity of thermal radiation per cathode unit surface area, j_M is the cathode current density corresponding to P_M, and φ is the work function corresponding to j_M at a given temperature. (ATD)

15004 THERMIONIC PROPERTIES OF ISOMORPHOUS CARBIDE ALLOYS. Samsonov, G. V.; Fomenko, V. S.; Paderno, V. N.; Rud', B. M. (Inst. of Material Science Problems, Academy of Sciences, Ukrainian SSR). pp 278-85 of Vysokotemperaturnye Neorganicheskie Soedineniya. Samsonov, G. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1965. (In Russian).

Thermionic properties of isomorphous carbide alloys TaC-ZrC, TaC-HfC, and HfC-NbC were measured as functions of the alloy concentration at 1100 to 2500°C. It was found that the performances of these alloys were better than those of the individual carbides, because of the increased force of interactions between the metallic atoms of the components. Changes in the solid-solution thermionic properties are determined by the ratio of the acceptor ability of metal atoms and the probability of the stable electron d^5-type configurations. (R.V.J.)

15005 ELECTRICAL EQUIVALENT CIRCUITS OF DC MHD GENERATORS. Celinski, Z. N. (Inst. of Nuclear Research, Warsaw). Advanced Energy Convers., 7: 67-75(Jan.-Mar. 1967).

The equivalent circuits of generators with the segmented electrodes electrically connected in various ways are determined (generators with the electrodes connected in series, and with Hall- and Faraday-connected electrodes). Constant gas dynamic

parameters, constant generator cross section, constant magnetic field, and uniformity of current density and electric field are assumed. Electrode effects, end effects, and "ion slip" are neglected. From the equivalent circuits the electrical terminal values of the generator as a function of the geometric dimensions of the generator, the Hall parameter, and the electrode connections system can easily be determined. (auth)

15006 GERMANIUM–SILICON, LEAD TELLURIDE, AND BISMUTH TELLURIDE ALLOY SOLAR THERMOELECTRIC GENERATORS FOR VENUS AND MERCURY PROBES. Fuschillo, N.; Gibson, R. Advanced Energy Convers., 7: 43-52(Jan.-Mar. 1967).

The design, theory, and fabrication of Bi_2Te_3 alloy solar thermoelectric flat plate generators for near-Earth orbit missions have been previously described. Consideration is given to the feasibility of extending the application to auxiliary power systems for exploratory missions towards the sun, for incident solar radiation fluxes from 130 to 1000 W/ft^2. The principal potential advantages of flat plate solar generator technology for these high solar fluxes are increased power per unit area, increased power per unit weight, increased power per unit cost, and increased radiation resistance. Design equations and computational techniques are discussed, which allow approximate solution for the generator output power as a function of distance from launch. Commercially available Bi_2Te_3 alloy, PbTe, and Si–Ge alloy materials are considered separately, though combined systems may offer a greater flexibility of power design for any particular mission. With "state-of-the-art" thermoelectric materials and emissive coating technology, and for the worst case of equal absorber and radiator plate areas, the principal results of these calculations are as follows: for near Mercury and Venus orbits, PbTe has a higher W/ft^2 (21 W/ft^2) than Ge–Si or Bi_2Te_3 alloy; but Ge–Si alloy has a higher W/lb of thermoelectric material (1000 W/lb). (auth)

15007 COMPARISON OF PELTIER–SEEBECK AND NERNST–ETTINGSHAUSEN ENERGY CONVERTERS IN INTERMEDIATE MAGNETIC FIELDS. Goldsmid, H. J.; Thomas, C. B. Advanced Energy Convers., 7: 33-41(Jan.-Mar. 1967).

The Peltier–Seebeck and Nernst–Ettingshausen figures of merit were calculated for a simple isotropic two-band model at intermediate magnetic field strengths. The results suggest that Peltier–Seebeck devices are likely to be more effective than Nernst–Ettingshausen devices. Furthermore, it appears that Peltier–Seebeck couples for use in magnetic field may, with advantage, be composed solely of n-type materials. The active branch of each couple would then be lightly doped while the passive branch would be heavily doped. Criteria for the choice of materials are discussed. (auth)

15008 THERMOELECTRIC THEORY OF A PLASMA DIODE. Boffi, V. C. (CNEN, Bologna); Molinari, V. G.; Parks, D. E. Advanced Energy Convers., 7: 1-22(Jan.-Mar. 1967).

The steady-state one-dimensional equations that govern the potential and temperature distributions in a plasma diode operating in the diffusion state are solved in closed form as a function of a parameter which is related by simple quadrature to the actual distance from one of the electrodes. From this solution it is possible to study in detail the electrical and thermal conduction problems and to construct the voltage–current characteristics of the diode. (auth)

15009 DIFFUSION THEORY OF AN IGNITED MODE THERMIONIC CONVERTER. Shaw, David Tai-ko (State Univ. of New York, Buffalo). Advanced Energy Convers., 7: 23-31(Jan.-Mar. 1967).

The plasma electron density and potential distributions are calculated for a planar, one-dimensional thermionic converter operated in the ignited mode. The analysis assumes a breakdown of quasi-neutrality and uses a new method to solve the Poisson's equation explicitly. (auth)

15010 THEORIES ET APPLICATIONS DE LA PHYSIQUE DES PLASMAS A BASSES TEMPERATURES. (Theories and Applications of Plasma Physics at Low Temperatures). Nowacki, P.-J. Saclay, France, Institut National des Sciences et Techniques Nucleaires, 1965. Paris, Presses Universitaires de France, 1965. 277p.

Magnetohydrodynamic generators and their theory and application in open and closed cycles are analyzed. The thermal ionization of gases, possible types of MHD generators, MHD generators with alternating current, the equations of the MHD generator, technical applications of plasmas at low temperatures, construction of plasmatrons, construction and technology of MHD generators, ionization during equilibrium, and the possibilities for the use of MHD generators in combination with nuclear reactors are considered in succession. (J.S.R.)

15011 DIRECT CONVERSION OF HEAT TO ELECTRICITY BY THERMIONIC EMISSION: ARC MODE OPERATION. Burgess, Edward Lee. Fayetteville, Ark., Univ. of Arkansas, 1966. 134p.

Thesis.

A study of the direct conversion of heat to electricity by thermionic emission has been completed using a cesium-filled thermionic energy converter operating in the low-temperature arc mode. Particular emphasis was given to the mechanism underlying the ionization of the cesium gas to yield positive ions for electron space-charge neutralization. The study included detailed experimental investigations of the thermionic energy converter operating in the arc mode and theoretical investigations of the ion generation mechanism in this mode of operation. Three parallel-plate electrode converters were tested over a range of emitter temperatures from 1373 to 1623°K, cesium reservoir temperatures from 413 to 573°K, and two interelectrode spacings of 0.05 and 0.20 centimeters, respectively. The current-voltage characteristics of each converter were measured for each of the operating conditions. The effects of changing each operating parameter are discussed. Three possible mechanisms leading to the formation of cesium ions by electron impact are considered theoretically: (1) electron impact with cesium ground state atoms to form cesium atomic ions, (2) electron impact with cesium excited atoms to form cesium atomic ions, and (3) impact of cesium excited atoms to form cesium molecular ions. Comparison of these three processes shows that molecular ion formation is dominant. A model is developed for predicting the current–voltage characteristics of the thermionic converter in which the space charge is neutralized by molecular cesium ions. A comparison of the theoretical current–voltage characteristics with the experimental characteristics shows good agreement. It is concluded that the electron space-charge neutralization in the arc mode of operation of the thermionic energy converter is provided by the formation of molecular ions. The conclusion is made on the basis of results from the theoretical analysis supported by experimental results. (Dissertation Abstr.)

15012 SOLAR WIND ENGINE, A SYSTEM FOR UTILIZING THE ENERGY IN THE SOLAR WIND FOR POWER AND PROPULSION. Moore, R. David (Electro-Optical Systems, Inc., Pasadena, Calif.). New York, American Institute of Aeronautics and Astronautics, 1966, Preprint No. 66-596, 33p., $1.50. (CONF-660608-11). DTIE.

From 2nd AIAA Propulsion Joint Specialist Conference, Colorado Springs, Colo.

The ionized plasma emitted by the solar corona provides a ready power source for space vehicles. To use this solar wind as an energy source, a vehicle would use two directed plasma beams. These plasma beams act as both the propulsion unit and as electrical conducting elements. The magnetic field carried with the solar wind induces an electric field along the beams, forcing a substantial current to flow from the solar plasma into one beam, through a power conversion system, and back to the solar plasma through the other beam. The output power from the power conversion system is sufficient to supply both the beam sources and other spacecraft demands, eliminating the need for any other prime power source. (auth)

Fluid Physics

15013 NUMERICAL EXPERIMENTS OF MAGNETOHYDRODYNAMIC SHOCKS AND THE STABILITY OF SWITCH-ON SHOCKS. Chu, C. K.; Taussig, Robert T. (Columbia Univ., New York). Phys. Fluids, 10: 249-56(Feb. 1967).

Numerical experiments are performed on a variety of magnetohydrodynamic shock waves to determine their behavior in a dissipative fluid. The Lundquist equations are integrated with Lax's finite difference scheme in which physical dissipation is imitated by numerical dissipation. Fast and slow magnetohydrodynamic shocks respond to small disturbances just as predicted by linear nondissipative theory. The disintegration of an intermediate (nonevolutionary) shock is followed in time to its final (stable) flow pattern. In this case, the disturbance builds up inside the shock structure to a maximum, and the shock splits into two shocks (e.g., a switchon and a switchoff shock) separated by a uniform region. This analysis gives the qualitatively correct time behavior of the splitting which, for small times, agrees with previous linearized dissipative results. The magnetohydrodynamic switchon shock is examined using the same techniques. Small transverse disturbances, which might split the shock according to a linear analysis, merely rotate the magnetic field in the plane of the shock (repolarize the shock) and leave an Alfvén wave tail behind it. The fluid dynamic properties of the shock are not changed, the shock does not split, and therefore the switchon shock is stable. In short, this approach overcomes the insufficiencies of linear, nondissipa-

tive analyses and gives physically realistic and reasonable answers to the long unresolved questions of magnetohydrodynamic shock stability. (auth)

15014 STATIONARY CONVECTION IN THE PRESENCE OF EXTERNAL MAGNETIC FIELD. Ivanilov, Yu. P.; Yakovlev, G. N. Prikl. Mat. Mekh., 30: 1140-6(Nov. Dec. 1966). (In Russian).

The stationary flow of a liquid over a limited region with a constant temperature gradient ΔT and a constant external magnetic field is considered with the use of dimensionless variables such as the following: $u^* = \nu\underline{u}/L$; $h^* = \rho_0\nu^3/\mu_e L^2\eta)^{0.5}\underline{h}$; $T^* = \beta L\nu T/x$; $\theta^* = \beta L\nu\theta/x$; $x_i^* = Lx_i$; $x = k\rho_0/c_v$, and $\eta = (\mu_e\sigma)^{-1}$. Here ν is the kinematic viscosity; L is a characteristic linear dimension; $\underline{u}$ and $\underline{h}$ are the liquid velocity vector and the vector of the magnetic field tension induced by the liquid motion; x_i are the Descartes coordinates; k is the thermal conductivity; c_v is the heat capacity; η is the magnetic viscosity; σ is the electrical conductivity; μ_e is the magnetic penetrability. The dimensional values are starred. Equations are given for the dynamic motion, thermal conductivity, induction, and incompressibility. A number of functional spaces are determined. (TTT)

15015 EQUATIONS OF MAGNETOHYDRODYNAMIC MACHINES. Nicolaide, Andrei (Institutul Politehnic, Brasov, Rumania). Electrotehnica, 14: 119-25(Apr. 1966). (In Rumanian).

Magnetohydrodynamics (MHD) studies the movement of conducting fluids in magnetic fields. Currents that modify the magnetic field are induced in the moving fluid and the interaction between the magnetic field and the currents modifies the fluid movement. The main applications of the MHD have initially been in astronomy and geophysics. The technical applications and especially the magnetohydrodynamic machines are now a highly interesting field. The equations of the magnetohydrodynamic machines are presented and the peculiarities of these equations as related to the nature of the fluid, which may be a liquid metal or an ionized gas, are discussed. (auth)

15016 MAGNETOHYDRODYNAMIC FLOW IN A RECTANGULAR PIPE BETWEEN CONDUCTING PLATES. Sloan, D. M. (Univ. of Strathclyde, Glasgow); Smith, P. Z. Angew. Math. Mech., 46: 439-43(Nov. 1966).

An exact solution is presented for the steady laminar flow of a viscous, incompressible, electrically conducting liquid in a rectangular pipe between conducting plates under the influence of an imposed transverse magnetic field. The problem is one of the few in which the induced magnetic field can be matched between the liquid and the plates. Numerical results are included for the exact solution and for an asymptotic representation suitable for large Hartmann numbers. (auth)

15017 STABILITY OF A COMPRESSIBLE, CONDUCTING FLUID IN THE PRESENCE OF A MAGNETIC FIELD. Gupta, M. M.; Gandhi, J. M. (Univ. of Rajasthan, Jaipur, India). Acta Phys. Austr., 24: 9-19(1966).

The equilibrium of a compressible, infinitely conducting fluid subjected to a uniform horizontal magnetic field and confined between two free boundaries is discussed. The fluid is stratified according to the law $\rho = \rho_0 \exp(\beta z)$ where ρ_0 is the density of the fluid at $z = 0$ and β is the stratification constant, z being the vertical axis which is also the direction of gravity. Here β is considered to be too small to consider any significant change in the velocity of sound and thus the velocity of sound is assumed to be constant, though the density of the fluid is varying. The results are graphically illustrated. One of the significant results is that the hydromagnetic waves are generated only for a limited range of wave numbers. The effect of the application of a magnetic field is to prevent the waves from being generated for all wave numbers. (auth)

15018 THEORY OF THE ELECTROSTATIC PROBE IN MAGNETOHYDRODYNAMIC FLUIDS. Whitman, Alan Morris. Philadelphia, Univ. of Pennsylvania, 1966. 120p.

Thesis.

An attempt is made to formulate a theory of electrostatic probes in a high-pressure plasma in which an external electrical field may be imposed. Such a situation exists in high-pressure arc discharges and in MHD channels. It is shown that an adequate theory must include the ionization and recombination phenomena ignored in almost all previous theories. Because of the preferred direction induced by the presence of the electric field, the probe problem is no longer a symmetrical one. The analysis is based on the assumption that the three-body recombination and ionization is the dominant process. The approximations of the classical boundary layer theory are used to obtain analytic solutions in closed form. It was found that the predictions of the theory agreed, in all the cases considered, with existing experimental findings. A notable success of the theory was the prediction of the correct value of ion saturation current obtained experimentally by Rohatgi and Emmons for a typical MHD working fluid. Another contribution of the theory is a theoretical current–voltage characteristic that includes the effect of sheath voltage drop. (TSS)

15019 THERMAL PROBLEMS IN MAGNETOHYDRODYNAMICS. Fillo, John Andrew. Syracuse, N. Y., Syracuse Univ., 1966. 133p.

Thesis.

For large magnetic Reynolds numbers, the classical theory of heat transfer in a boundary layer is extended to the laminar, magnetohydrodynamic case in which a viscous, electrically conducting, incompressible fluid flows past an electrically insulated semi-infinite flat plate in the presence of a uniform magnetic field parallel to the oncoming free-stream velocity. Both the cooling and magnetic thermometer problems are studied. Prandtl numbers of order one (slightly ionized gases) and of order 10^{-2} to 10^{-3} (highly ionized gases) are of primary interest in the analysis as well as both large and small magnetic Prandtl numbers. In addition to the method of asymptotic expansions, an approximate integral method is utilized to find solutions to the thermal boundary layer equations. A heat transfer analysis for flow past the surface of a conducting solid body is also presented. In the case of free convection, study is focused on the flow of an electrically conducting, viscous fluid past a vertical flat plate with constant or variable wall temperature. An exact solution to the time-dependent equations is found for the limiting case of magnetic Reynolds number $\to 0$. In addition, the two-dimensional free convection boundary layer equations are derived for large magnetic Reynolds numbers and similarity solutions are found for these equations. Numerical solutions are also obtained by approximate means for Prandtl numbers of order one, magnetic Prandtl numbers in the range 0.1 to 1 and magnetic pressure numbers in the range 0 to 1. The problem of free convective flows subject to variable fluid properties and small magnetic Reynolds numbers is also treated. It is established for both the forced and free convective modes of heat transfer that the effect of the magnetic field is to reduce the heat transfer between the plate surface and the fluid streams. (Dissertation Abstr.)

15020 IMPROVEMENTS IN OR RELATING TO MAGNETOHYDRODYNAMIC GENERATORS. (to Licentia Patent-Verwaltungs GmbH). British Patent 1,054,967. Jan. 11, 1967. Priority date Apr. 26, 1963, Germany.

The magnetohydrodynamic generator described comprises a flow path for a fluid conductive medium passing through a magnetic field extending in a first transverse direction to the flow so as to produce an electromotive force in a second transverse direction perpendicular to the first. The width of the flow path is relatively large in the second transverse direction and increases progressively in the direction of flow. Dividing walls extending in the direction of flow divide the flow into parallel paths. (W.D.M.)

15021 IMPROVEMENTS IN OR RELATING TO MAGNETOHYDRODYNAMIC ELECTRICAL GENERATOR SYSTEMS. Broom, Trevor (to Central Electricity Generating Board). British Patent 1,051,092. Dec. 14, 1966. Filed Mar. 24, 1964.

The invention includes an open-cycle MHD electrical power generator system in which fuel is burned with air. The air is preheated by regenerative preheaters, which are switched cyclically. Means are provided for the periodic injection of oxygen into the air feed at the preheater change-over frequency. The rate of injection of oxygen is controlled automatically to vary cyclically at the preheater change-over frequency in such a manner as to maintain the temperature of the combustion products substantially constant or to maintain the power output of the generator substantially constant. (W.D.M.)

Geophysics

Refer also to abstracts 14928, 15129, and 15143.

15022 (AFCRL-66-741) COMPUTED ELECTRON, ION, AND NEUTRAL DENSITY PROFILES FOR THE SOLAR ECLIPSE OF 12 NOVEMBER 1966. Environmental Research Papers, No. 233. Keneshea, Thomas J.; Fowler, Ronald J. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). Sept. 28, 1966. 36p. CFSTI $3.00 cy, $0.65 mn.

A general computer model of the ionospheric behavior during a solar eclipse is briefly described. Solutions are generated for 15 ionospheric species during the solar eclipse of 12 November 1966. These solutions are for altitudes from 60 to 120 km, and include both neutral and charged species. (auth)

15023 (LA-DC-6769) ANGULAR DISTRIBUTION OF PARTICLES AND MAGNETOSPHERIC ANISOTROPY AT 17 EARTH RADII. Bame, S. J.; Asbridge, J. R.; Felthauser, H. E.; Olson,

R. A.; Strong, I. B. (Los Alamos Scientific Lab., N. Mex.). [1965]. Contract W-7405-eng-36. 17p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Measurements made on the Launch 2 Vela satellites of properties of the solar wind protons near and in the transition region are reported. Some characteristics of the electrons in the same regions and in the magnetosphere are also presented. Data are included on solar wind proton energies, proton boundaries, and proton angular distributions. Evidence is given for a tilted magnetospheric boundary, and an anisotropy in electron activity on the dawn and twilight sides of the magnetosphere. (J.H.M.)

15024 (N-66-27056) ELECTRON DENSITIES AND SCALE HEIGHTS IN TOPSIDE IONOSPHERE: ALOUETTE I OBSERVATIONS IN MIDLATITUDES, SUMMER 1963; WINTER 1963-1964. Thomas, John O.; Rycroft, Michael J.; Colin, Lawrence (National Aeronautics and Space Administration, Moffett Field, Calif. Ames Research Center). 1966. 658p. (NASA-SP-3026). CFSTI $3.00 cy, $0.65 mn.

Data are presented on electron density (N) and plasma scale height (H) at a series of heights (h) and times (t) in the topside ionosphere. The quantity H is defined as $H = -N/(dN/dh)$. The tabulated N(h,t) and H(h,t) data were computed from Alouette I topside ionograms. An overlapping polynomial method of analysis which has been described elsewhere was used. The calculations were programmed for an electronic digital computer. The complete program of reduction is shown, and includes results over a range of dip latitudes extending from approximately 20° to 80° north for summer and winter months at a sunspot minimum epoch of the solar cycle. The curves presented show the winter and summer variations of the electron density (N) and scale height (H) with local time (diurnal variations), and dip latitude (latitude variations) at a series of altitudes (h) in the topside ionosphere as calculated from the tabulated values of N and H. (auth)

15025 (N-66-35728) FIRST ORDER TECHNIQUE FOR THE MEASUREMENT OF VEHICLE POTENTIAL IN THE IONOSPHERE. Bettinger, Richard T. (Maryland Univ., College Park). Aug. 1965. 16p. (NASA-CR-68767). CFSTI $3.00 cy, $0.65 mn.

Under certain conditions, the potential of vehicles immersed in the ionospheric plasma can become very large. In addition, the presence of on-board equipment (e.g., dc sweeps) often gives rise to significant variations in this potential. The use of a small diameter, cylindrical Langmuir probe is suggested as a means of measuring the artificially induced variations of potential with good accuracy. This technique will also provide crude information (approximately 1 V) on the vehicle potential as controlled by the geophysical parameters. (auth)

15026 (N-67-10253) AVERAGE PROPERTIES OF THE SOLAR WIND AS DETERMINED BY MARINER II. Neugebauer, Marcia; Snyder, Conway W. (Jet Propulsion Lab., Pasadena, Calif.). Nov. 1, 1966. Contract NAS7-100. 37p. (NASA-CR-79321; JPL-TR-32-991). CFSTI $3.00 cy, $0.65 mn.

Positive-ion component properties of the solar wind are summarized for the four months of the Mariner II flight to and past Venus in 1962. Average proton velocity and temperature were approximately 500 km/sec and 1.7×10^{5}°K, respectively. Several streams of hot, high-velocity plasma were observed to recur at 27-day intervals, with peak velocity and temperature values of ≈830 km/sec and 9×10^{5}°K. One of these streams probably existed for at least 18 months. Between streams, velocity dropped to a low of 307 km/sec, while the temperature was $\approx 3 \times 10^{4}$°K. Near 1 AU, average density was approximately 5 protons/cm^3. The density was usually highest at the leading or western edge of each stream, with a maximum value of ≈80 protons/cm^3. Otherwise, the density varied inversely with the plasma velocity. Ion velocity, temperature, and density were calculated by fitting data to isotropic Maxwell-Boltzmann distributions in a reference frame moving away from the sun at the solar-wind velocity. Observed spectra usually had high-energy tails, which became more pronounced at the higher plasma velocities. The velocity, temperature, and high-energy tail were not strongly dependent on distance from the sun, whereas the density varied approximately as the inverse square of this distance. (auth)

15027 (NASA-SP-114(Vol.6)) SPACE TECHNOLOGY. VOLUME VI. SPACE SCIENCES. Farley, T. A. (California Univ., Los Angeles). 1966. 84p. GPO $0.35.

Information on steady and variable components of the near geomagnetic field is reviewed. The ring current and magnetosphere are discussed in relation to variations of the distant geomagnetic field. Information is included on the location of the Van Allen radiation belt with respect to the earth, charged-particle motion, energy spectra and distribution of trapped protons, energy spectra and distribution of trapped electrons, sinks and sources of trapped particles, composition of interplanetary medium, solar wind, interplanetary magnetic field, composition and origins of cosmic radiation, and the origin, structure, and orbits of comets. Discussions are also included on instrumentation for space research. (J.H.M.)

15028 (USNRDL-TR-1082) BETA DOSE RATES FROM NEUTRON-IRRADIATED ^{235}U CARBIDE PARTICLES. Pestaner, J. F.; Kubose, D. A.; Balkwell, W. R. (Naval Radiological Defense Lab., San Francisco, Calif.). June 30, 1966. Contract AT(49-5)-2505. 29p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Small highly radioactive particles could be injected into the biosphere from the reentry and burnup of a nuclear propulsion reactor. This would constitute a potential radiological hazard to man. The experimental measurement of beta dose rates from fission products contained in pyrolytic-carbon-coated uranium-235 carbide beads of core diameter 90, 120, and 260 μ is reported. The dose was measured in an extrapolation chamber using tissue equivalent electrodes. The beta dose from the irradiated particles delivered to a segment of tissue can be calculated using a rate law derived from the experimental values. (auth)

15029 A SIMPLE METHOD FOR ESTIMATING AN ENHANCED IONIZATION IN THE LOWER IONOSPHERE. Ondoh, Tadanori; Kishida, Hideo (Radio Research Labs., Nakaminato, Japan). Rep. Ionosphere Space Res. Jap., 20: 542-52(1966).

Methods are discussed for estimating height distributions of enhanced ionization in the lower ionosphere by using a riometer to measure ionospheric absorption of cosmic radio noises. A simple and practical method for computing the enhanced ionization from the ionospheric absorption data is proposed. Riometer data were obtained at 20, 25, 30, 40, and 50 Mc at Hiraiso, Japan. Height profiles of the enhanced electron density for SID's are derived by the multiple-frequency method. (J.H.M.)

15030 HEATING OF THE THERMAL PLASMA IN THE INNER MAGNETOSPHERE. Tamao, Tsutomu (Tokyo Univ.). Rep. Ionosphere Space Res. Jap., 20: 537-41(1966).

It was previously reported that, if the radial distributions of the density and the temperature of the magnetospheric plasma obtained by Serbu and Maier are adopted, a large rate of energy production in the magnetosphere is necessary near the equatorial plane to maintain the stationary temperature distribution against the high heat conduction along the lines of force of the geomagnetic field. Possible sources of this energy production in the inner magnetosphere are examined. (J.H.M.)

15031 ELF NOISE-BURSTS AND ENHANCED OSCILLATIONS ASSOCIATED WITH THE SOLAR FLARE OF JULY 7, 1966. Ogawa, Toshio; Tanaka, Yoshikazu; Miura, Teruo; Owaki, Makoto (Kyoto Univ.). Rep. Ionosphere Space Res. Jap., 20: 528-36(1966).

During the solar flare event of July 7, 1966, abnormal broad band bursts and enhanced regular oscillations of 14 to 18 cps were observed in the vertical electric field component of natural ELF electromagnetic noises. Some resulting discussions are made in relation to the properties of the earth-ionosphere cavity resonances. (auth)

15032 PHOTOELECTRONIC PROCESSES IN THE UPPER ATMOSPHERE. II. THE HYDROGEN AND HELIUM ULTRAVIOLET GLOW AS AN ORIGIN OF THE NIGHTTIME IONOSPHERE. Ogawa, Toshihiro; Tohmatsu, Takao (Tokyo Univ.). Rep. Ionosphere Space Res. Jap., 20: 395-417(1966).

The hydrogen and helium ultraviolet glows in the night sky are considered as sources of the electrons and ions in the nighttime ionosphere between 80 and 200 km. The intensities of H I 1026 Å (L_β), He I 584 Å, and He II 304 Å (L_α) emissions at night are estimated with the assumption that they originate in the geocorona. They, with the observed intensity of H I 1216 Å (L_α) glow, are used to evaluate the ionization rate at night. Equilibrium values of electron and ion densities are obtained. The decay of the charge densities in the transient time between day and night is numerically calculated at different altitudes. The charge density in 90 through 150 km is found to be maintained above 10^3 cm^{-3} throughout the night. The maximal electron density is approximately 2.5×10^3 cm^{-3} at 105 km, if the intensities of the 1216 Å and 1026 Å glow are assumed to be 4 kR and 10 R respectively. It is concluded that currently believed role of the 1216 Å glow for the ionization of nitric oxide is important only below the 100 km level, while the 1026 Å glow becomes an important ion source in the altitudes above 100 km. The 584 Å and 304 Å glow may contribute appreciably to the production of O^+, O_2^+ and N_2^+ above 150 km, although their brightness is as small as 10 R and 1 R respectively. The present results are shown to be in fundamental agreement with the average feature of nighttime ionosphere ever observed. (auth)

15033 THEORETICAL STUDIES OF THE AIRGLOW RESONANT EMISSION TRANSFER. Tohmatsu, Takao; Ogawa, Toshihiro (Tokyo Univ.). Rep. Ionosphere Space Res. Jap., 20: 418-38(1966).

A mathematical treatment of the transfer of airglow resonant emissions in Doppler incoherent scattering medium is discussed with a special respect to optically thick atmosphere. The radiative transfer functions are given in explicit expressions. These functions are tabulated in a style convenient for numerical calculations. The radiative amplification of airglow resonant emissions in optically thick atmospheres is discussed with the help of these functions for the case, where the failure of the reemission conservation and the dissipative absorption of photons exist. (auth)

15034 LARGE AMPLITUDE VARIATIONS OF THE INTENSITY OF OXYGEN 5577 A EMISSION IN THE NIGHT AIRGLOW AND THE STRUCTURE OF LOWER THERMOSPHERE. Saito, Bun-iti; Takahasi, Tosiyasu (Niigata Univ., Japan). Rep. Ionosphere Space Res. Jap., 20: 439-47(1966).

The presence of two types of variation in the oxygen 5577 Å emission in the airglow is suggested. For the phenomena of larger amplitude type, some characteristics such as the amplitude, the rate of intensity variation, the seasonal variation, the geographical distribution and the geomagnetic dependence are derived. The importance of quenching by O_2 molecules is pointed out. Thus, the 5577 intensity variation is expected to be one of the most sensitive indicators of the structure of lower thermosphere, consisting chiefly of O atoms and O_2 molecules. In connection with the O_2 molecules' quenching, it is suggested that the detection of the atmospheric 7879 Å band in the airglow and the aurora is quite important. (auth)

15035 ON INTENSITY DECREASE OF THE HYDROMAGNETIC SHOCK WAVE THROUGH NON-UNIFORM MAGNETOSPHERE. Okuzawa, Takashi (Tokyo Univ.). Rep. Ionosphere Space Res. Jap., 20: 464-79(1966).

Applying the Chisnell–Whitman method to the one-dimensional propagation of the stationary HM shock wave passing through the magnetospheric medium, in which density and magnetic and gas pressures are regarded as a succession of small-scale discontinuities separated by uniform regions, the shock strength given initially as 8.5 at 10 earth radii is numerically calculated as a function of geocentric distance under the first-order approximation. Related quantities behind the wave front are also computed. In comparing the results with those of previous work, it is emphasized that the decreasing shock strength is due not only to partial reflection of the wave resulting from nonuniformity of the medium but also due to the effect of spreading out an interval between the cavity surface, which is assumed to act like a piston moving compressively toward the earth, and the emitted shock wave front. An additional computation is made for the case of nonuniform temperature which is assumed to be proportional to the square of geocentric distance. (auth)

15036 INFLUENCE OF SOLAR ACTIVITY ON THE EXTENT OF THE DIURNAL FLUCTUATION OF MAGNETIC COMPONENTS IN VIENNA. Steinhauser, Peter (Univ., Vienna). Arch. Meteorol. Geophys. Bioklimatol., Ser. A, 15: 349-71(Apr. 1966). (In German).

The relation between the diurnal variation of geomagnetic parameters and solar activity was investigated for the years 1955 to 1962 on the basis of the standard deviation of the hourly means from the daily average, and of the Fourier waves of the 24- and 12-hr period as functions of the relative sunspot numbers. It was shown that the standard deviation of the diurnal variation and both Fourier amplitudes initially increase rapidly with the sunspot number; the increase becomes more moderate with larger sunspot numbers. Intensity of this damping varies with the various parameters of the different components. The relations between the solar activity and the degree of the disturbance of the diurnal variation of the geomagnetic elements were also investigated, and some possible explanations for these results are discussed. (BBB)

15037 SUNRISE EFFECT IN THE LONG WAVELENGTH RANGE. Israel, H.; Roessler, J. (Technische Hochschule, Aachen). Z. Geophys., 32: 207-15(Aug. 1966). (In German).

Changes of propagation of long-wavelength radio signals by the ionosphere occurring at sunrise were examined. From January 1 to December 31, 1962, daily records were made of the decay of the reception field strength of the vlf transmitter at Balboa, Panama (18 Kcs), in Aachen, during the change from darkness to daylight conditions of propagation. The decay was regularly superimposed by patterns of wave-like shape interpreted as the so-called satellites caused by the formation of the D layer after sunrise of the points of reflection. The times of the satellite occurrence could be explained to a satisfactory degree by considering the means of propagation in terms of changes in ionospheric conditions. (BBB)

15038 MAGNETIC FIELD OF THE IONOSPHERIC DYNAMO. Hall, S. H. (Imperial Coll. of Science and Tech., London). Contemp. Phys., 7: 430-9(Nov. 1966).

A description is given of the transient variation of the earth's magnetic field known as the quiet day variation field and the Sq and L ionospheric dynamo current systems that can be inferred from its characteristics. Sounding rocket investigations of the magnetic field discontinuities obtained when this current system is penetrated are reviewed and the need to measure other dynamo parameters is discussed. (auth)

15039 SOME FEATURES OF EQUATORIAL IONOSPHERIC STORMS. Olatunji, E. O. (Ibadan Univ., Nigeria). Ann. Geophys., 22: 485-91(July-Sept. 1966).

Ionospheric storm changes in f_0F2, h_mF2, the sub-peak columnar electron content, and the total columnar electron content were analyzed. Time and intensity relations between ionospheric and magnetic storms were also examined. Near the magnetic equator, f_0F2 tends to be higher by day, and less by night, than the quiet-day value. An increase of f_0F2 is accompanied by an increase in the total columnar electron content by day. Most of the storm change observed in ionization densities takes place in the upper F2 layer. For most storms, h_mF2 is not significantly altered. An ionospheric storm generally begins 0.5 to 5 hr after the onset of a magnetic disturbance, with a tendency for the storm to start first in the night-time ionosphere. During a magnetic storm, the ionosphere is, as a rule, disturbed. The ionospheric disturbance, however, does not correlate with magnetic indices Kp or Ap; i.e., there is a definite non-Kp or non-Ap element in ionospheric storms. Thus, 2 features present difficulties in accepting electrodynamic control as a major factor in the disturbed ionosphere: viz, lack of correlation between $\Delta f_0F2/f_0F2$ or the total columnar ionization and Ap or Kp, and continuation of the ionospheric storm for a day or more after the end of the magnetic storm. Changes of neutral composition and/or temperature offer a more plausible explanation of this behavior. (BBB)

15040 ORIGIN OF FLUCTUATIONS IN THE EQUATORIAL ELECTROJET: A NEW TYPE OF GEOMAGNETIC VARIATION. Nishida, Atsuhiro; Iwasaki, Noboru; Nagata, Takesi (Tokyo Univ.). Ann. Geophys., 22: 478-84(July-Sept. 1966).

World-wide morphology of principal types of magnetic variations at the equator is presented, and the origin of these variations is sought. Part of them can be identified as previously described phenomena, but most of them seem to belong to a new class of geomagnetic variation. They appear at the equator as decreases in the field intensity, with a time scale ranging from half an hour to several hours, and their magnitude occasionally becomes comparable with the amplitude of the S_q. The equivalent current for this variation consists, in each hemisphere, of 2 highly asymmetric vortices originating from the polar cap current flow. These variations were found over a half of the sample interval of 270 hr, and they seemed to result from the fluctuation in the electric field of magnetospheric origin. The magnitude of the electric potential across the current vortex is, for larger cases, about 50 kV. Variations of the present type are usually superposed, in the polar cap, on S_q^{ν} variation in such a way as to reduce its amplitude, and the activity of the present variation seems greater when the S_q^{ν} amplitude is larger. This would indicate that the present variation is related to fluctuations in the viscous-like force operating on the magnetopause considered responsible for S_q^{ν}, but the pronounced asymmetry of the 2 vortices, as well as the extension of the current flow toward low latitudes, cannot be explained by this mechanism alone. (BBB)

15041 STUDY BY TWO CONJUGATED POINTS OF RADIOELECTRIC EMISSIONS OF VERY LOW FREQUENCY (0.8 TO 10 kHz). Kleimenova, Natalia (Inst. of Physics of the Earth, Moscow); Troitskaya, Valeria; Dassac, Marguerite; Gendrin, Roger; Ponsot, Claude; Vigneron, Jacques. Ann. Geophys., 22: 519-29(Oct.-Dec. 1966). (In French).

Comparison was made of the vlf emissions (mainly 1.5 to 3 kc) recorded at the conjugate geomagnetic stations at Sogra and Kerguelen. Some statistical results over a period of 1 yr are analyzed. They deal with the diurnal variation, mean variation, most probable value of Kp, and the delay between magnetic activity and the occurrence of vlf emissions. The characteristics of conjugacy were studied. Hiss was always recorded simultaneously at both stations, dawn chorus never, except during strong ionospheric storms. When these storms corresponded to a strong diminution of f_0F_2, they were preceded by a dawn chorus emission that appeared at both stations between 14 and 18 hr before the storm. When storms corresponded to positive deviations of f_0F_2, they were neither accompanied nor preceded by dawn chorus emission. During the periods of absolute magnetic quietness, no vlf emission occurred. Analysis of the fast magnetic perturbations showed that some type of pi 1 occurs simultaneously with hiss,

but that dawn chorus never occurs simultaneously with pc 1. In 80% of the cases, the delay between pearls and chorus or chorus and pearls was at least 5 hr. (BBB)

15042 MECHANISM FOR THE PERIODIC DRIFT VIOLATING THE LONGITUDINAL INVARIANT FOR TRAPPED PARTICLES IN THE MAGNETOSPHERE. Beghin, C. (Groupe de Recherches Ionospheriques, Paris). Ann. Geophys., 22: 549-52(Oct.-Dec. 1966). (In French).

The effect of standing transverse hydromagnetic waves on the particles trapped along a line of force of the earth's magnetic field was studied. The energy of the mirroring particles is considered to be such that their bounce period is much less than the period of the hydromagnetic oscillations. It is shown that the particles are subject to a transverse drift, whose integrated effect, over one period of the hydromagnetic oscillations, leads to a periodic displacement of the particle trajectory about its mean position with the same period. This effect causes a violation of the longitudinal invariant of the particle motion with the consequence that, in favorable cases, some of the particles are precipitated by atmospheric diffusion, and the rate of precipitation varies rhythmically in synchronism with the hydromagnetic oscillations. (BBB)

15043 THEORETICAL MODEL FOR THE MAGNETIC DECLINATION EFFECT IN THE IONOSPHERIC F REGION. Goldberg, Richard A. (Goddard Space Flight Center, Greenbelt, Md.). Ann. Geophys., 22: 588-98(Oct.-Dec. 1966).

The equatorial F region of the ionosphere exhibits geomagnetic control when studied using magnetic inclination or dip. The phenomenon, referred to as the geomagnetic anomaly, exhibits itself more strongly in the topside region because of the reduced effect of collisions. Studies of f_0F2 have also indicated that magnetic declination influences the behavior of the F-region ionosphere, and that this effect is not limited to low latitudes. It was demonstrated that the geomagnetic anomaly distribution can be described in terms of a nonaccelerating electron density distribution under the influence of electric, magnetic, and gravitational forces and the effects of production and loss. It is suggested that these individual magnetically aligned planes of ionization can be correlated by a longitudinal density distribution as a boundary condition, this distribution being geographically oriented because its variations are primarily under solar control. This concept is introduced into the equations by a current system, necessary to create a balance of forces under equilibrium conditions. The intermixing of a geographically controlled longitudinal distribution with a geomagnetically controlled latitudinal distribution then gives a consistent picture of the declination effects previously reported in the literature. Furthermore, it enables shapes and behavior of the distribution, heretofore unstudied, to be predicted. (BBB)

15044 DIFFUSIVE EQUILIBRIUM IN THE TOPSIDE EQUATORIAL IONOSPHERE. Rishbeth, Henry (Radio and Space Research Station, Slough, Eng.); VanZandt, Thomas E.; Norton, Richard B. Ann. Geophys., 22: 538-48(Oct.-Dec. 1966).

Field-aligned electron concentration profiles of the equatorial anomaly, from 300- to 1000-km altitude, were constructed from vertical profiles deduced from the Alouette I space probe ionograms. It was found that the field-aligned profiles have nearly the same shapes as theoretical profiles derived assuming diffusive equilibrium in the plasma consisting of O^+, He^+, H^+, and electrons. The theoretical profiles are described by 4 parameters: the plasma temperature, $(T_e + T_+)/2$; the transition height where the O^+ and He^+ concentrations are equal; the function of H^+ at that height; and the electron concentration at that height. These parameters were found by comparing the observed theoretical profiles. For 4 afternoons during 1963, it was found that the plasma temperature ranged from 840 to 1000°K, that the transition height was about 600 km, and that at the transition height the proportion of H^+ ions was generally about 10%. These parameters are reasonably consistent with determinations of temperature and ion composition obtained from the Ariel I satellite. It was also found that the equatorial ledge is prominent only in the region where the ions are predominantly He^+ and H^+. (BBB)

15045 RAPID GEOMAGNETIC ACTIVITY AT VERY LOW-LATITUDE CONJUGATE STATIONS. Heirtzler, J. R. (Lamont Geological Observatory, Palisades, N. Y.); de Mendonca, F.; Montes, H. Ann. Geophys., 22: 502-7(July-Sept. 1966).

Geomagnetic total field intensity measurements were made in New York and Sao Paulo (Brazil), at opposite ends of a line of force that passes through the F region. The activity was similar in great detail especially for periods greater than 40 sec. There was abundant small-scale micropulsation activity at all periods but 50- to 70-sec period activity was most frequently observed and that type event occurred most frequently at local noon. Measurements were made during the December solstice when the sun was far south and the average S_q foci skewed in a similar direction. The great similarity of the coherent micropulsations suggests that they were beneath a current in a single hemisphere. A micropulsation current system with return flow through the auroral zone has been proposed. These observations could be due to such a system. Magnetic measurements of all 3 components of field strength, made at various seasons of the year at these conjugate stations, should give definitive results on the micropulsation current system in equatorial latitudes. (BBB)

15046 A REVIEW OF THE EQUATORIAL STUDIES OF RAPID FLUCTUATIONS IN THE EARTH'S MAGNETIC FIELD. Campbell, Wallace H. (Inst. for Telecommunication and Aeronomy, Boulder, Colo.). Ann. Geophys., 22: 492-50(July-Sept. 1966).

Studies of equatorial geomagnetic field fluctuations in the frequency range of 4.0 to 0.003 cps are reviewed. Such natural phenomena are investigated to understand processes transpiring in the local ionosphere and the distant magnetosphere. Even though some signals in the equatorial region have unique characteristics that could best resolve source and propagation mechanisms, the progress of equatorial studies in these frequencies has been slow compared to that of the middle and high latitudes, probably as a result of the greater scarcity of equatorial geophysical laboratories. Known micropulsation characteristics are summarized to indicate the significance of equatorial observations in the global picture. It appears that further basic study programs are needed for the regular sinusoidal type oscillations, particularly in the higher frequency band. For such field pulsations, equatorial experiments should be designed to resolve ionospheric current system sources from the horizontally ducted wave and radial hydromagnetic wave arrivals. Irregular pulsations in the equatorial region should be utilized for obtaining more definitive information on the S_q and equatorial electrojet distribution. (BBB)

15047 CONCENTRATION OF ^{14}C IN THE ATMOSPHERE AT THE TIME OF THE TUNGUS CATASTROPHE, AND ANTIMATTER. Vinogradov, A. P.; Devirts, A. L.; Dobkina, E. I. (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 168: 900-3(June 1, 1966). (In Russian).

The reasons for the Tungus catastrophe could have been due to the crash of a comet or meteor, a nuclear or chemical reactions, or a reaction involving antimatter. A total of $2.7 \pm 1.4 \times 10^{27}$ neutrons would have been formed as a result of the annihilation of the antimatter, and a total of about 7% additional ^{14}C would have been produced by a $^{14}N(n,p)^{14}C$ reaction. Libby and Cowan found only an increase of 0.6% for the year of 1909. Samples were obtained from annual growth rings of trees in the area of the Tungus catastrophe, and the ^{14}C content was determined on a CO_2 proportional counter with a working volume of 1.5 liters. An activity increase of 0.3% was detected in the years of 1907-1910 as compared to the years of 1885-1890. This increase is not statistically significant, since the ^{14}C content of the atmosphere varied by about 2% over a period of 170 years. It is concluded that the Tungus catastrophe was not related to the incursion of antimatter into the earth's atmosphere. (TTT)

15048 COLLISIONLESS DAMPING OF LOW FREQUENCY HYDROMAGNETIC WAVES IN THE MAGNETOSPHERE. Patel, V. L. (Rice Univ., Houston, Tex.). Earth Planet. Sci. Lett., 2: 36-40(Jan. 1967).

It is shown that low-frequency hydromagnetic waves in the magnetosphere can be damped without collisions. Effects of the thermal motion of the particles is significant in the damping process. Damping coefficients are calculated in the vicinity of the magnetopause on the day side and the tail region in the night side of the magnetosphere. Waves with angular frequencies $\omega = 0.1$ to 0.5 radian/sec are damped heavily. Transfer of the energy from the solar wind to the magnetosphere on the day side and the effect of the shape of the tail are discussed. Continuous supply of the internal energy due to this wave damping could affect the shape of the magnetospheric tail. Large particle fluxes observed by Explorer 12 and IMP-I near the magnetopause inside the magnetosphere may be due to the transfer of energy from the waves to the particles. (auth)

15049 THEORY OF THE WINTER ABSORPTION ANOMALY AT MIDDLE LATITUDES. Sechrist, C. F. Jr. (Univ. of Illinois, Urbana). 59p. (CONF-660443-6). DTIE. Gmelin, AED-CONF-66-142-17.

From International Scientific Radio Union Conference, Washington, D. C.

Examination of mesospheric temperature profiles obtained by the rocket-grenade technique at Wallops Island, Virginia, has revealed the occurrence of mesospheric warming on certain winter days. A preliminary investigation has indicated that f_{min} values observed with ionosondes at Wallops Island and Ft. Belvoir, Virginia, tend to be higher on days when the mesospheric tempera-

tures are abnormally high. Because higher values of f_{min} may be associated with enhanced ionization in the D region, it is believed that the increased values of f_{min} are caused by a sporadic D layer. A theory of the formation of a sporadic D layer at middle latitudes in winter is presented. Use is made of the experimental temperature profiles to obtain estimates of the nitric oxide distribution in the D region on an average winter day and on nontypical winter days at Wallops Island. The temperature and nitric oxide distributions are utilized to calculate the electron production rates; electron density distributions are derived from these assuming an effective recombination coefficient of 5×10^{-7} cm^3 sec^{-1}. On the basis of the calculated nitric oxide and electron density distributions, and examination of f_{min} values from ionograms, it is concluded that the winter anomaly in ionospheric radio absorption is explicable in terms of a temperature inversion in the D region on certain winter days at middle latitudes. Also, examination of f_{min} values and stratospheric temperatures during November, 1963, indicates that November 17, 1963, was a nontypical winter day at Wallops Island; and it is suggested that the D region nitric oxide concentration measured by Barth on that date was abnormally high because of a sporadic warming in the D region. (auth)

15050 TEMPORAL VARIATIONS OF THE POLAR MESOSPHERIC OXYGEN AND OZONE DURING AURORAL EVENTS. Maeda, Kaichi; Aikin, A. C. (Goddard Space Flight Center, Greenbelt, Md.). 67p. (CONF-640817-2). DTIE. Gmelin, AED-CONF-64-164-11.

From International Atmospheric Ozone Symposium, Albuquerque, N. Mex.

Temporal solutions are given of the photochemical equations describing the distribution of ozone and atomic oxygen in the mesosphere in both the equatorial and polar regions. Similar calculations applied to auroral events indicate a strong dependence of mesospheric atomic oxygen on the intensity and energy spectrum of auroral electrons, which dissociate molecular oxygen. The distributions during auroral events do not contradict the ozone densities required to explain the OH-band airglow observations made during auroral activities. It is also shown that atomic oxygen and ozone concentration in the polar mesosphere do not reach equilibrium even at equinox. (auth)

15051 LABORATORY SIMULATION OF A SATELLITE MOUNTED PLASMA DIAGNOSTIC EXPERIMENT. Kasha, M. A.; Johnston, T. W. (RCA Victor Research Labs., Montreal). 9p. (CONF-660639-6). DTIE. Gmelin, AED-CONF-66-221-8.

From Congress-Canadian Association of Physicists, Sherbrooke, Quebec.

The successful laboratory simulation of a direct-measurement plasma diagnostic experiment, of the type carried by several earth satellites, including the electromotive effect of the satellite's motion through the earth's magnetic field, is reported. Plasma is formed by the discharge of a lithium-seeded plasma gun at one end of a flight tube. The plasma flows along this tube and into an interaction chamber. The interaction chamber is situated in the magnetic field produced by a Helmholtz coil assembly, the field direction being perpendicular to the direction of plasma flow. Scaling conditions and experimental results are discussed. (M.O.W.)

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Refer also to abstracts 14513, 14807, and 15408.

15052 (AD-639214) LOW TEMPERATURE SPECIFIC HEAT OF Sn AND Sn-In ALLOYS. Wilkes, William Roy (Illinois Univ., Urbana, Dept. of Physics). July 1966. Contract DA-31-124-AROD-359. 107p. (AROD-2771:12). CFSTI $3.00 cy, $0.65 mn.

The normal-state specific heats of pure tin and alloys consisting of 0.5, 1, 2, 4, and 6 atomic percent indium in tin were measured between about 0.4 and 4.2°K. All of the alloys lie within the solid solubility limit of indium in tin. Measurements were made in an adiabatic calorimeter cooled by a ^{3}He refrigerator, with the specimens magnetically quenched from the superconducting state. Additional cooling of some specimens was possible by adiabatic magnetization to achieve temperatures as low as 0.24°K. The results for pure tin are compared with recent data for the temperature coefficient of the normal electronic specific heat, gamma, and the Debye temperature, theta. The results for the alloys are interpreted in terms of the variation in gamma and theta, and comparisons are made with recent determinations of the variations of gamma and theta with increasing indium concentration. While the variation of theta is in reasonable agreement with reported values, the variation of gamma with increasing indium content is positive, in disagreement with previously reported data. The results are also discussed in the light of the theories of Markowitz and Kadanoff and of Ginsberg on the variation of the critical temperatures of superconductors with alloying. (TAB)

15053 (MIT-3700-3) RESEARCH ON INSTABILITY IN SUPERCONDUCTING MAGNETS. Technical Progress Report, April 1, 1966-December 31, 1966. (Massachusetts Inst. of Tech., Cambridge. National Magnet Lab.). Jan. 18, 1967. Contract AT(30-1)-3700. 12p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Results of work on the basic instability of superconducting wires are reported. Progress is reported on thermal stabilization of inherently unstable material by using heat sinks of solid material rather than liquid helium, resulting in a higher packing factor in a coil. (M.H.R.)

15054 CONTRIBUTION TO THE THEORY OF FOURTH SOUND ABSORPTION. Sanikidze, D. G.; Adamenko, I. N.; Kaganov, M. I. Zh. Eksp. Teor. Fiz., 52: 584-93(Feb. 1967). (In Russian).

The damping coefficient of fourth sound in a plane parallel capillary or in a system of plane parallel capillaries is calculated by applying the helium-II two-fluid hydrodynamics equations. Sound damping is due to a viscosity mechanism of energy dissipation and to heat flow through the capillary walls. (auth)

15055 LINEAR FLOW VELOCITY OF A FILM IN HELIUM ISOTOPE SOLUTIONS. Esel'son, B. N.; Bogatyrev, I. F.; Ivantsov, V. G.; Shcherbachenko, R. I. Zh. Eksp. Teor. Fiz., 52: 380-2(Feb. 1967). (In Russian).

The temperature and concentration dependences of the linear velocity of flow of a film in ^{3}He-^{4}He solutions are studied at temperatures ranging from 1.5°K to T_λ and ^{3}He concentrations between 2 and 16%. The linear velocity values obtained are appreciably greater than those calculated on basis of the mass velocity and film thickness data cited in the literature. This discrepancy can apparently be explained by the effect of vortexes on the film flow velocity. (auth)

15056 NUCLEATION OF SUPERCONDUCTIVITY AT A TUNNELING BARRIER. Boyd, R. G. (Univ. of Colorado, Boulder). Phys. Lett., 24A: 204-5(Feb. 13, 1967).

Earlier calculations of the parallel critical field of a tunneling barrier (valid for T near T_c) to all temperatures T in the dirty limit are extended. The critical field is intermediate between H_{c2} and H_{c3} when the barrier resistance R_n is in the range $\rho\xi(T)$ to 10 $\rho\xi(T)$. (auth)

15057 ac JOSEPHSON EFFECT IN SUPERFLUID HELIUM. Khorana, B. M.; Chandrasekhar, B. S. (Western Reserve Univ., Cleveland). Phys. Rev. Lett., 18: 230-2(Feb. 13, 1967).

An experiment described earlier by Richards and Anderson as "phase slippage" due, for example, to the motion of quantized vortices across a hole connecting two volumes of superfluid helium at the same temperature and between which a gravitational mass difference exists, was repeated. The results are reported. (M.O.W.)

15058 CRITICAL TEMPERATURE OF SMALL SUPERCONDUCTORS. Shapoval, E. A. (Moscow State Univ.). JETP Lett. (USSR) (Engl. Transl.), 5: 45-8(Jan. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 57-61(Jan. 15, 1967).

It is known that the critical temperature of sufficiently small superconductors (nonannealed films) increases with decreasing dimensions. It is shown that the growth of the critical temperature of small samples can be explained within the framework of the BCS superconductivity theory without making use of any new electron-pairing mechanism whatsoever. (M.O.W.)

15059 SUPERCONDUCTIVITY IN A NONEQUILIBRIUM SYSTEM. Batev, E. G. (Semiconductor Physics Inst., Academy of Sciences, Siberian SSR). JETP Lett. (USSR) (Engl. Transl.), 5: 35-7(Jan. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 45-8(Jan. 15, 1967).

The gap in a superconductor decreases with increasing temperature because of the temperature smearing of the electron Fermi distribution. Some means of reducing this smearing is assumed. The effective temperature of a metal can be lowered by current flowing through a semiconductor-metal-semiconductor sandwich. The superconducting properties of this system are discussed. (M.O.W.)

15060 SUPERCONDUCTIVITY OF METALLIC ALUMINUM ANTIMONIDE. Wittig, Joerg (Technische Hochschule, Karlsruhe, Ger.). Science, 155: 685-6(Feb. 10, 1967).

The high-pressure metallic phase of aluminum antimonide is superconducting [critical temperature T_c (P ~ 125 kilobars) = 2.8 ± 0.2°K]. This transition temperature is significantly lower than the transition temperature of metallic germanium under an equivalent high pressure. A similar result had been previously

found for superconducting indium antimonide in comparison to tin. (auth)

15061 PHENOMENOLOGICAL LANDAU-GINZBURG THEORY FOR ANISOTROPIC SUPERCONDUCTORS. Bennett, Alan J.; Falicov, L. M. (Cambridge Univ., Eng.). Phys. Rev., 154: 302-9(Feb. 10, 1967).

The Landau–Ginzburg theory is extended to include the case of superconductors with anisotropic energy gaps. The approach is essentially phenomenological; the anisotropy is introduced via the dependence of the order parameter of the original theory on a vector k as well as on position r. The parameter k is interpreted to be the Fourier conjugate of the relative coordinate of the members of the superconducting pairs. Both diffuse and specular boundary scattering are considered. The equations are obtained in a general form and solutions are presented for the half space, a thin film, and a small sphere in the absence of an external field. (auth)

15062 SUPERCONDUCTIVITY OF α-URANIUM AND URANIUM COMPOUNDS AT HIGH PRESSURE. Gardner, W. E. (Atomic Energy Research Establishment, Harwell, Eng.); Smith, T. F. Phys. Rev., 154: 309-15(Feb. 10, 1967).

The pressure dependence of the superconducting transition temperature T_c of α uranium has been measured to a maximum pressure of 22 kbar and constitutes an important extension of the pressure range of previous measurements. It has been observed that T_c increases rapidly as a function of pressure up to ~9 kbar, passes through a broad maximum, and then decreases. A possible explanation of this behavior is offered on the basis of a pressure-induced transformation in the electronic properties of uranium. Data are also reported for observations of the T_c under pressure of the compounds U_6Fe and U_6Mn and the solid solution alloy $U_{0.85}Mo_{0.15}$. (auth)

15063 POWER DISSIPATION IN A HARD SUPERCONDUCTING TUBE. Wischmeyer, C. R. (Rice Univ., Houston, Tex.). Phys. Rev., 154: 323-9(Feb. 10, 1967).

Two kinds of dissipation are computed for a macroscopically homogeneous sample subjected to a changing axial magnetic field. Based upon the Anderson–Kim model of critical states, the induction, current density, electric field intensity, and thence the Joulean power density are determined. All are significantly dependent upon radial distance and magnetic history. Reversal of an applied field produces within the sample an interface region in which neighboring fluxoids are in opposite directions. Pairs of opposing fluxoids are presumed to coalesce, giving up their line energies as heat in an annihilation process. By way of illustration, computed values of all these quantities are presented for a typical unannealed $Nb_{0.75}$ $Zr_{0.25}$ sample. If the computed values of dissipation, which are averages in the sense that they are based upon a homogeneous model, are taken to be a measure of the thermal activation of flux motion, then their pattern affords a highly satisfactory explanation of an extensive body of experimental observations. (auth)

15064 SUPERCONDUCTING- AND NORMAL-STATE THERMAL CONDUCTIVITY OF IMPURE TIN. Pearson, G. J.; Ulbrich, C. W.; Gueths, J. E.; Mitchell, M. A.; Reynolds, C. A. (Univ. of Connecticut, Storrs). Phys. Rev., 154: 329-37(Feb. 10, 1967).

Low-temperature measurements of the normal- and superconducting-state thermal conductivities were made on ten tin specimens, one of which was pure (99.996%) and nine of which were lightly doped (up to 1 at.%) with mercury, lead, or bismuth. The ratios K^s/K^n of the superconducting- to normal-state thermal conductivity are used to analyze the data. The normal-state thermal conductivity is assumed to consist of a fractionally small lattice component K_g^n consistent with the universal-curve formalism of Lindenfeld and Pennebaker, added to a much larger electronic component of the Wiedemann–Franz type. The superconducting lattice thermal conductivity K_g^s is assumed to be simply related to K_g^n in a manner roughly independent of impurity concentration. Proceeding in this manner, it is shown that the variation of K^s/K^n with changing electronic mean free path is consistent with a normal-state lattice conductivity having a temperature dependence similar to that observed by other investigators on other alloy systems. Furthermore, if one quantitatively adopts the universal-curve formalism, it is seen that the analysis yields a temperature-dependent ratio of lattice conductivities, K_g^s/K_g^n, which is consistent with the theory of Bardeen, Rickayzen, and Tewordt. The thermal conductivities of the pure and the three lowest impurity samples are mostly electronic, and thus it is possible to compare their K^s/K^n ratio with the theoretical K_e^s/K_e^n ratio of Kadanoff and Martin, calculated for an isotropic gap. The pure-sample data fit the theory with a value of $3.3k_BT_c$ for the superconducting energy gap. However, a value of $3.9k_BT_c$ is found for the gap for the three impure samples. (auth)

15065 ENERGY GAP AND THERMAL CONDUCTIVITY OF PURE AND IMPURE SUPERCONDUCTING TIN. Ulbrich, C. W.; Markowitz, D.; Bartram, R. H.; Reynolds, C. A. (Univ. of Connecticut, Storrs). Phys. Rev., 154: 338-45(Feb. 10, 1967).

A theory is presented for the energy gap and the thermal conductivity in pure and impure tin. The central features are taken from the papers of Markowitz and Kadanoff and of Hohenberg and include anisotropy in the pure material, which is systematically eliminated by increased doping. First the usual theory of thermal conductivity is generalized to allow for gap anisotropy. Next an anisotropic gap function for pure tin is constructed using experimental results of other investigators. Synthesizing these two stages yields a prediction for the thermal conductivity of pure superconducting tin as a function of orientation and temperature. This prediction is in fair agreement with the data of Guénault. In the impure metal, the gap depends upon four quantities: energy ω, angle Ω, mean free path l, and temperature T. Simplifications are introduced whereby the complicated dependences are separated into simpler factors. Stress is laid upon the distinction between anisotropy in the gap edge and the effect of anisotropy on quantities such as the average gap and T_c. The gap edge is rendered isotropic by impurities well before the effect is felt by the other quantities. In fact it is the gap edge that is vital to thermal conductivity, since it is there that the carriers reside. Predictions for thermal conductivity in impure tin are compared with data of Pearson et al., and found to show good qualitative agreement. In particular, a reduction in the ratio of superconducting to normal thermal conductivity for certain sample directions is explained by the elimination of gap-edge anisotropy. However, this effect occurs at a much smaller impurity concentration than that predicted theoretically. This discrepancy and related matters are fully discussed. (auth)

15066 MIXED STATE OF TYPE-I SUPERCONDUCTING FILMS IN A PERPENDICULAR MAGNETIC FIELD. Lasher, Gordon (IBM Watson Research Center, Yorktown Heights, N. Y.). Phys. Rev., 154: 345-8(Feb. 10, 1967).

Thin films of type-I superconductors are shown to exist in a variety of quite distinct mixed states, depending on their thicknesses. The most interesting of these states consist of hexagonal arrays of vortices of larger than unit quantum number. Their general character falls between that of the ordinary mixed state, a triangular array of unit vortices that occurs for sufficiently thin films, and the intermediate states consisting of islands of superconducting phase in a matrix of normal phase that occurs for sufficiently thick films. The theory is developed in Abrikosov's high-field approximation, which gives solutions of the Ginzburg–Landau equations that are exact in the limit as the applied field approaches the second critical field H_{c2}. Two critical thicknesses are found and determined as functions of the Ginzburg–Landau parameter κ. The first and smaller critical thickness is the maximum film thickness for which the ordinary mixed state will exist near H_{c2}. The second critical thickness is the maximum for which a second-order field transition occurs at H_{c2}. The new types of mixed state are stable for values of film thickness intermediate between these two. (auth)

15067 RELAXATION OF THE SUPERCONDUCTING ORDER PARAMETER. Lucas, G.; Stephen, M. J. (Yale Univ., New Haven). Phys. Rev., 154: 349-53(Feb. 10, 1967).

The creation and annihilation of quasiparticles in a superconductor through their interaction with the phonon field is examined. At low frequencies this appears to be the main mechanism leading to relaxation of the order parameter in a superconductor. The relaxation time becomes long both close to T_c and at low temperatures. Close to T_c, a diffusion equation for the order parameter is obtained. The correlation in time of the fluctuations of the order parameter is examined. A weak coupling between the amplitude and phase of the order parameter is shown to lead to a slow diffusion of the phase of the order parameter. (auth)

15068 ISOSPIN FORMULATION OF THE THEORY OF A GRANULAR SUPERCONDUCTOR. Parmenter, R. H. (RCA Labs., Princeton, N. J.). Phys. Rev., 154: 353-68(Feb. 10, 1967).

The properties of a granular superconductor are studied with the aid of the isospin formulation of the microscopic theory of superconductivity. The system consists of grains of homogeneous superconductor separated by insulating but tunnelable barriers (Josephson junctions). The general nonlinear equations of motion are set up for the isospins, "spin up" representing the absence, and "spin down" the presence, of a given Cooper pair. These equations are like torque equations for each isospin moving in an effective pseudomagnetic field due to all the other isospins. Linearized solutions result in various single-particle and collective excitations. A certain class of nonlinear solutions is shown to satisfy a Ginzburg–Landau-like differential equation. The effects

of electric fields (within the junctions) and real magnetic fields are studied, one result being that there are bulk electromagnetic modes analogous to the surface modes known to be associated with a single isolated Josephson junction. Consequences of changes in temperature and changes in effective electron–electron interaction are studied. (auth)

15069 MAGNETOACOUSTIC ATTENUATION IN HIGH-FIELD SUPERCONDUCTORS. Shapira, Y.; Neuringer, L. J. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 154: 375-85 (Feb. 10, 1967).

A phenomenological model for the magnetic-field variation of the ultrasonic attenuation in the mixed and normal states of a high-field superconductor is developed. It is shown that the attenuation in the mixed state is related to the motion of the Abrikosov flux lines and is greatly affected by the strength of the pinning forces that inhibit this motion. The pinning forces are characterized by the depinning frequency ω_0. At frequencies well above ω_0 the attenuation is directly related to the dc flow resistivity. A method for determining ω_0, and hence the strength of the pinning forces, from ultrasonic data are outlined. Ultrasonic-attenuation measurements were carried out on five different high-field superconducting alloys, viz., annealed Nb–25 at. % Zr, Nb–32 at. % Ti, V–42 at. % Ti, V–21 at. % Ti, and unannealed Nb–25 at. % Zr. These measurements were performed at liquid-helium temperatures and in steady magnetic fields up to 100 kG. Shear and longitudinal sound waves, with frequencies ranging from 8 to 56 Mc, were used. The data are compared in detail with the predictions of the phenomenological model. It is found that in all cases there is good agreement between experiment and theory. In particular, it is shown that estimates of the depinning frequency obtained from the ultrasonic data agree with those derived from critical-current measurements carried out on the same materials. (auth)

15070 LATTICE INSTABILITY OF HIGH-TRANSITION-TEMPERATURE SUPERCONDUCTORS. I. POLYCRYSTALLINE A-15 COMPOUNDS. Testardi, L. R.; Soden, R. R.; Greiner, E. S.; Wernick, J. H.; Chirba, V. G. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 154: 399-401(Feb. 10, 1967).

The A-15 (β tungsten) structure compounds Nb_3Sn, Nb_3Al, Nb_3Ga, V_3Si, and V_3Ga, which are all superconducting above 14°K, have been found to exhibit elastic softening on cooling. The anomalous temperature dependence of the elastic moduli disappears in the superconducting state. This ususual behavior does not occur for the isostructural compounds V_3Ge and Nb_3Ge, which have comparatively low transition temperatures ($T_c \sim 5$ to 7°K). (auth)

15071 LATTICE INSTABILITY OF HIGH-TRANSITION-TEMPERATURE SUPERCONDUCTORS. II. SINGLE-CRYSTAL V_3Si RESULTS. Testardi, L. R.; Bateman, T. B. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 154: 402-10 (Feb. 10, 1967).

Sound-velocity measurements in V_3Si have shown that the modulus modulus $(C_{11} - C_{12})/2$ for [110] shear waves with $[1\bar{1}0]$ polarization falls from a value at room temperature typical of the metallic state to near-zero magnitude in the superconducting state, while the bulk modulus $(C_{11} + 2C_{12})/3$ is constant to 0.5% in the same temperature interval. The attenuation of the soft shear mode increased markedly on cooling. A large increase in attenuation for all modes occurs with the structural transformation at 21°K reported by Batterman and Barrett. The transformation, triggered by the small shear stiffness, is arrested with the onset of the superconducting state. The distortions of the structural transformation are found to be comparable in magnitude with the thermal stains resulting from the soft shear mode. The behavior of the high-frequency phonons involved in the superconductivity is not known, although the specific-heat and electrical-resistivity data indicate that they may be stiffer than the near-liquidlike low-frequency phonons. The lattice instability may result from a very strain-sensitive structure in the density-of-states distribution near the Fermi level. The unusual elastic behavior reported here for V_3Si is probably characteristic of most high-temperature superconductors. (auth)

15072 MICROWAVE TRANSMISSION- AND REFLECTION-COEFFICIENT RATIOS OF THIN SUPERCONDUCTING FILMS. Rugheimer, N. M.; Lehoczky, A.; Briscoe, C. V. (Univ. of North Carolina, Chapel Hill). Phys. Rev., 154: 414-21(Feb. 10, 1967).

Measurements of the transmission and reflection of 12-, 8-, and 4-mm microwaves through thin (~50 Å) superconducting films of tin and indium were made as a function of temperature below the superconducting transition temperature. A vacuum microwave cryostat with the waveguide passing straight through the system was used to make the measurements. A movable sample block made it possible to condense and anneal the films and make microwave measurements without removing the films from the vacuum. Superconducting complex electrical conductivities as formulated by Mattis and Bardeen were used to compute transmission- and reflection-coefficient ratios for comparison with experimental values. In the majority of cases the agreement between experiment and theory is quite good. In some cases the assumption of a superconducting energy gap of $2\Delta(0) = 2.82kT_c$, instead of the predicted $2\Delta(0) = 3.52kT_c$, improved the fit between experiment and theory. The temperature at which the microwave transmission and reflection differ measurably from their values in the normally conducting states can be used as a definition of the critical temperature. Transition temperatures measured in this manner are in close agreement with the usual dc definition. (auth)

15073 SEARCH FOR SURFACE SUPERCONDUCTIVITY INDUCED BY AN ELECTRIC FIELD. Meissner, Hans (Stevens Inst. of Tech., Hoboken, N. J.). Phys. Rev., 154: 422-4(Feb. 10, 1967).

The electrical and thermal conductivity of rather thick films of tin was used to investigate the possibility of surface superconductivity induced by the presence of an electric field normal to the surface of the film. No such effect was found. (auth)

15074 SUPERCONDUCTIVITY IN THE ALLOY SYSTEM INDIUM–THALLIUM. Merriam, M. F.; Hagen, J.; Luo, H. L. (Univ. of California, San Diego, La Jolla). Phys. Rev., 154: 424-35(Feb. 10, 1967).

The superconducting transition temperatures of over 75 samples spanning the entire composition range of the indium–thallium alloy system have been measured. The highest T_c measured was about 3.8°K in the bcc phase; the lowest was 2.5°K in the fcc phase. In all phases, T_c decreases with increasing Tl content, the rate of decrease in the tetragonal (indium) phase being, however, much less steep than in the other phases. The Seraphim empirical rule, $\Delta T_c = k_1x + k_2 \ln x$, is found not to describe the data in the dilute thallium range. An anomaly in the T_c-versus-composition plot at 4.4 at. % Tl is extremely similar in form to one previously identified in In–Cd as a Brillouin-zone effect. Transition temperature and isothermal magnetization data are used to locate the two-phase region separating the tetragonal and cubic phases; the boundaries of this region are 30.1 ± 0.4 and 31.7 ± 0.3 at. % Tl at 3.3°K. The existence of such a region indicates that the tetragonal–cubic transformation is first-order, in agreement with the earlier room-temperature calorimetric work of Predel. The transition temperature of bcc Tl was estimated by extrapolation of the bcc alloy data to zero solute concentration; the result was 2.49°K. (auth)

15075 SUPERCONDUCTING TRANSITIONS IN BODY-CENTERED-CUBIC THALLIUM–INDIUM ALLOYS. Luo, H. L. (Univ. of California, San Diego, La Jolla); Willens, R. H. Phys. Rev., 154: 436-8(Feb. 10, 1967).

The superconducting transition temperature and the lattice parameter of the body-centered cubic phase in the In–Tl system are reported. The transition temperature of bcc Tl is extrapolated to be 3.0 ± 0.1°K. The linear thermal-expansion coefficient of the bcc alloys is computed to be 29×10^{-6}/°K between 77 and 300°K independent of composition. (auth)

15076 ELASTIC CONSTANTS OF THE FLUX LINE LATTICE IN TYPE-II SUPERCONDUCTORS. Labusch, R. (Univ., Goettingen, Ger.). Phys. Status Solidi, 19: 715-19(Feb. 1, 1967). (In German).

The elastic constants of the flux line lattice in type-II superconductors are recalculated from the interaction potential between the flux lines, avoiding an error made in previous calculations. Assuming triangular symmetry, it is shown that the constants can be expressed in terms of the measured reversible magnetization curve. The calculated elastic constants of the flux line lattice in niobium at 4.15°K are plotted as functions of the applied magnetic field. (auth)

15077 NMR STUDY OF TWO ENERGY GAPS IN SUPERCONDUCTING COMPOUNDS. Asayama, Kunisuke; Yamagata, Hideki (Osaka Univ.). J. Phys. Soc. Jap., 22: 347-8(Jan. 1967).

Measurements are reported on the nuclear relaxation times of ^{93}Nb and ^{27}Al in Nb_3Al and ^{51}V and ^{119}Sn in V_3Sn. The pulsed magnetic resonance method in the flux quantized intermediate state was used. (W.D.M.)

15078 VANISHING KNIGHT SHIFT IN SUPERCONDUCTOR ALUMINUM. Hammond, R. H.; Kelly, G. M. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Rev. Lett., 18: 156-8(Jan. 30, 1967).

A new measurement of the Knight shift in superconducting aluminum is reported which differs from a previous result in that now the Knight shift extrapolates to a value at T = 0°K which is essentially zero. This is as predicted by the BCS theory of superconductivity, according to which the ground state consists of a coherent superposition of Cooper pairs in singlet spin states. (M.H.R.)

15079 DISSIPATIVE HEAT PRODUCTION BY CONSTANT GRAVITATIONAL SUPERFLUID FLOW IN He II. van Alphen, W. M.; Olijhoek, J. F.; de Bruyn Ouboter, R.; Taconis, K. W. (Kamerlingh Onnes Laboratorium, Leiden). Physica, 32: 1901-4(Oct. 1966).

The detection of energy dissipation in superfluid flow is used as a technique to study the critical velocity and friction of the superfluid component in He II. The apparent flow resistance consists of a non-dissipative (Bernoulli) and a dissipative part, the latter also varies as the square of the superfluid velocity. (auth)

15080 PERSISTENT CURRENTS IN DOUBLY CONNECTED SUPERFLUID HELIUM. Sikora, Paul; Hammel, E. F.; Keller, W. E. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Physica, 32: 1693-9(Oct. 1966). (LA-DC-7727).

When a current of superfluid helium is impressed across an asymmetric doubly connected region around which no circulation exists, the state of zero circulation is maintained provided all velocities remain subcritical. If the current is increased the velocity in the shorter channel (assuming the width of each channel the same) will eventually reach its critical value. Further increase of the current will result in the generation of circulation which remains trapped in the system when the current is reduced to zero. (auth)

15081 ACOUSTIC IMPEDANCE OF LIQUID ^{3}He: THEORY. Brooker, G. A. (Oxford Univ.). Proc. Phys. Soc. (London), 90: 397-416(Feb. 1967).

Some calculations were made of the acoustic impedance of liquid ^{3}He, in order to analyze the experimental results of Keen, Matthews and Wilks [Proc. Roy. Soc. A, 284: 125-36(1965)] and of Betts, Keen and Wilks [Proc. Roy. Soc. A, 289: 34-45(1965)]. According to the theory of a Fermi liquid, due to Landau, the propagation of sound in liquid ^{3}He should show an anomaly when the period of oscillation is made less than the relaxation time of the liquid. Landau predicts that a new type of wave motion, called zero sound, should propagate in this case. The calculations show that there is good agreement between the measured value of the acoustic impedance and that expected for a Fermi liquid supporting zero sound. It is concluded that the experimental results provide strong evidence for the existence of zero sound. The agreement between theory and experiment, while close, is not perfect, so the approximations made in calculating the acoustic impedance were examined in the hope of obtaining further information. It seems that the sequence of parameters describing the interaction of quasi-particles, F_0, F_1, F_2, ... , which is usually carried only as far as F_1, should be extended to include F_2. Rough estimates of F_2 are made by two different methods; the agreement is not very close, but is considered satisfactory. (auth)

15082 SPINS AND CRYOGENICS. Kurti, N. (Oxford Univ.). Contemp. Phys., 8: 21-40(Jan. 1967).

To reach temperatures below those attainable with the help of liquefied gases one must make use of the elementary magnets associated with electrons and nuclei. After a discussion on the scope and the limitations of the ordinary magnetic cooling method, some of its present and possible future uses in various fields, such as cryopumping, magnetism, superconductivity, and the properties of liquid helium are described. The nuclear cooling method and the ways in which it could be used to open up the temperature range below 10^{-3}°K for various types of experiments are discussed. (auth)

Plasma and Thermonuclear Physics

15083 DISSIPATIVE WAVE PROPAGATION IN COMPRESSIBLE MAGNETOHYDRODYNAMICS. Salathe, Eric P.; Sirovich, Lawrence (Brown Univ., Providence). Phys. Fluids, 10: 372-80(Feb. 1967).

A complete discussion of the linearized, compressible magnetohydrodynamic equations is given. No restriction is placed on any of the dissipative mechanisms, and moreover the nature of the gas is unspecified. Fundamental solutions are obtained for arbitrary values of the pertinent dimensionless parameters as well as field orientation. Use of the fundamental solutions is illustrated by the construction of solutions for several problems. Various inviscid limits are considered, and restrictions on inviscid theory thereby result. (auth)

15084 MAGNETICALLY IMPLODED METAL FOILS. Freeman, J. R.; Cnare, E. C.; Waag, R. C. (Sandia Corp., Albuquerque, N. Mex.). Appl. Phys. Lett., 10: 111-13(Feb. 15, 1967).

An analytic method for predicting the mechanical and electrical behavior of a magnetically imploded metal foil is discussed. A lumped-parameter electrical circuit model was used. The behavior of the primary circuit current, the foil radius, and the approximate magnetic fields at the center of the foil were computed as functions of time. The results were compared with experimental results previously reported. The comparisons for the foil radius and the primary circuit current were reasonable; there was a larger discrepancy in the magnetic field comparison. (A.G.W.)

15085 VYSOKOCHASTOTNYE SVOISTVA PLAZMY. (High-Frequency Properties of Plasma). Sinel'nikov, K. D. (ed.). Fizika Plazmy i Problemy Upravlyaemogo Termoyadernogo Sinteza. (Plasma Physics and Problems of Controlled Thermonuclear Fusion). Kiev, Naukova Dumka, 1965. 217p.

Separate abstracts were prepared for the 23 individual papers. (M.O.W.)

Confinement and Heating of Plasma

Refer also to abstracts 15142, 15187, 15202, and 15207.

15086 (NRL-6422) CLAMP SYSTEM FOR THE PHAROS 2-MJ CAPACITOR BANK. Young, M. P.; Lupton, W. H.; Kolb, A. C. (Naval Research Lab., Washington, D. C.). Jan. 25, 1967. 13p.

A clamp system is now in operation on the Pharos magnetic-compression experiment's two-MJ primary capacitor bank. Clamping the discharge circuit at the current maximum (about 17 MA with 16 μsec risetime) converts the normal damped oscillatory waveform to an aperiodic current with an exponential decay time constant of more than 200 μsec. This conversion permits study of the plasma in a region where the confinement time is no longer limited by the duration of the confining field. An important feature of the clamp-circuit design is the isolation of individual clamp switches by the starting switches during the capacitor charging period. Thus, only a small fraction of the total bank energy is dissipated in the clamp switch in the event of a prefire. The 420 parallel clamp switches, developed at NRL, are a variation of the Pharos air trigatron starting switch, except that they are housed in a commercial Pyrex tee and evacuated to one millitorr. The clamp-switch terminals, which are an integral part of the electrodes, allow direct mounting between the capacitor high-voltage stud and ground plates. No modification to the existing capacitor bank was required for installation, so the experimental program was not disrupted. (auth)

15087 (UCRL-50161) CALCULATION OF TOROIDAL MAGNETIC FIELD CONFIGURATIONS. Killeen, John; Furth, Harold P.; Freis, Robert P. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 10, 1967. Contract W-7405-eng-48. 60p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Several computer programs used to calculate magnetic surfaces in a torus are described. Applications include helically wound stellarators and axially symmetric floating ring devices. Evaluation of the relevant hydromagnetic stability criteria, such as $dV/d\psi$, is included in the calculations. Automatic plotting routines for the graphical display of the surfaces are part of the programs. Fortran listings of the programs are included. (auth)

15088 CONFINEMENT OF CHARGED PARTICLES BY MULTIPLE-MIRROR SYSTEMS. Post, R. F. (Univ. of California, Livermore). Contract W-7405-eng-48. Phys. Rev. Lett., 18: 232-6(Feb. 13, 1967). (UCRL-70008).

Monte Carlo techniques are used to evaluate particle confinement in mirror systems, including ones in which several mirrors are used in series. Predictions are compared with an experiment, and possible advantages of multiple-mirror systems with respect to plasma stability are described. (auth)

15089 METHOD OF INJECTING CHARGED PARTICLES INTO A MAGNETIC MIRROR SYSTEM. Volosov, V. I.; Pal'chikov, V. E.; Tsel'nik, F. A. Zh. Tekh. Fiz., 36: 1649-51(Sept. 1966). (In Russian).

L. A. Artsimovich has shown that charged particles can be injected into a magnetic mirror machine by projecting them in the region of the mirror at a small angle to the plane normal to the magnetic field during establishment of the mirror field. It is shown here that it is possible, similarly, to inject charged particles from behind the mirror, provided the strength of the magnetic field at the injection point is kept proportional to that of the mirror field during establishment of the latter. To test the method, 100-keV electrons were injected into a 40-cm-diameter, 150-cm-long magnetic mirror system with a mirror ratio of 2.5. The injector consisted of a ring-shaped electron gun mounted on the axis of the system, which produced a conical beam of electrons making an angle of 20° with the plane normal to the axis, i.e., having a vertex angle of 140°. The magnetic field at the electron gun was kept proportional to the mirror field during the rise of the latter with the aid of a special pulsed solenoid mounted within the chamber. With a beam spread of 10°, some 10% of the injected

electrons were trapped between the mirrors. The lifetime of the trapped electrons within the trap was from 0.01 to 0.1 sec and was limited only by scattering on the residual gas. There was observed an increase in the fraction of the injected electrons that were trapped with increasing injection current. This increase is in accord with the theory and is due to space charge effects. (ATD)

15090 TOROIDAL PLASMA TRAPS WITH SPATIAL MAGNETIC AXES. Bazhanova, A. E.; Glagolev, V. M.; Shafranov, V. D. Zh. Tekh. Fiz., 36: 1575-84(Sept. 1966). (In Russian).

Plasma confinement in magnetic fields of the type that can be produced by an endless solenoid wound through and about a circular torus is discussed. These fields can be regarded as generalizations of the figure-eight type stellarator field proposed by L. Spitzer. V. D. Shafranov has previously shown that the displacement of the magnetic surfaces of the field of a solenoid in the presence of plasma is determined by the curvature and torsion of the axis of the solenoid. Formulas are derived for the curvature and torsion of solenoids of the type considered, and the distortion of their magnetic surfaces in the presence of plasma is discussed. Topologically equivalent torus–solenoid configurations in which the solenoid axis consists of line segments and circle arcs are also treated. It is concluded that the distortion of the magnetic surfaces is minimum when the solenoid axis makes an angle of about 45° with the torus axis, and that a suitable value of the ratio of the gas pressure to the magnetic pressure for optimal conditions is 0.1. (ATD)

15091 MAGNETIC SURFACES OF A DIRECT HELICAL MAGNETIC FIELD IN THE PRESENCE OF AXIAL CURRENT. Aleksin, V. F.; Sebko, V. P. Zh. Tekh. Fiz., 36: 1594-1600 (Sept. 1966). (In Russian).

With the aid of a circular multiple-beam electron gun (500 to 3000 eV) it is established that the maximum radius of the magnetic surfaces of a stellarator increases and its minimum radius decreases with increase in axial current from 0 to 500 A, in the presence of a longitudinal magnetic field of from 0 to 1.5×10^3 Oe. Photographs of magnetic surface cross sections indicate that they are triangle-shaped when the direction of the axial current is opposite to the direction of the longitudinal magnetic field and circle-shaped when both these directions are the same. The deviation of experimental findings from theory is found not to exceed 15%. (JPRS)

15092 CONTRIBUTION TO THE EXPRESSION OF PARTICLE MOVEMENT IN MAGNETIC MIRROR SYSTEMS IN CYCLIC VARIABLES. Krlin, L. (Inst. of Plasma Physics, Prague). Czech. J. Phys., 17: 112-23(1967).

An expression is presented for the hamiltonian function of a particle in a static, axially symmetric magnetic field in convenient variables. Assuming adiabaticity (the relative change of the magnetic field during one cyclotron revolution can be neglected), the hamiltonian function is determined with cyclicity in two degrees of freedom. For the determination of the hamiltonian function either the Cartesian, or the orthogonal curvilinear system, was used as a starting coordinate system. The latter consists of a natural system of lines of force and equipotentials of the field. In both cases a hamiltonian function of the form $H = H(P_1, P_2, P_3, Q_3)$ is obtained, where P_i are generalized impulses and Q_3 longitudinal coordinates. The form of hamiltonian function is very simple; it facilitates appreciably the integration of the equations of motion and provides simple expressions for the integrals of motion. (auth)

15093 ACTION-ANGLE COORDINATES FOR PARTICLE MOTION IN MAGNETIC MIRROR SYSTEMS. Krlin, L. (Inst. of Plasma Physics, Prague). Czech. J. Phys., 17: 124-32(1967).

The problem of the possibility of determining the cyclic hamiltonian function of a particle moving about a magnetic vessel of the mirror type is discussed. From the hamiltonian of the type $H = H(P_1, P_2, P_3, Q_3)$, derived by the author in a previous paper, the hamiltonian function $H = H(J_1, J_2, J_3, \omega_3)$ was determined where P_i, Q_i are the generalized impulses and coordinates and J_i, ω_k is the action-angle coordinate system. The determination of the form $H = H(J_1, J_2, J_3)$ depends on the possibility of solving the quadrature of the Hamilton–Jacobi equation leading to an open form in the general case. Some approximative expressions, suitably replacing the mirror system, are discussed. The solution has been extended to the range of relativistic velocities. The question of the uniqueness of the expression of the hamiltonian function in cyclic variables is analyzed; it follows from this that the class of canonical transformations leaving the hamiltonian in a cyclic form does not allow any great simplification of the relatively complicated transformation expressions. (auth)

15094 SHOCK TUBE AND PLASMA DYNAMICS. Kantrowitz, Arthur (Avco-Everett Research Lab., Everett, Mass.). Nav. Res. Rev., 19: 1-9(Feb.-Mar. 1966).

Recent developments in magnetohydrodynamic (MHD) generators are reviewed. To date, practical MHD generators have been restricted to combustion heat sources utilizing fossil fuels, because only such heat sources can provide high enough temperatures to thermally ionize the working plasma. One such generator, which is described and illustrated, utilizes a rocket-engine-type combustion chamber, has produced 20 MW net power output, plus 12 MW to drive its field coil. MHD generators, which now have reached the stage of practical applications for short-time power needs, are being developed also for commercial central-station generating plants. The use of nuclear reactors as heat sources for MHD generators is also under study. At present, nuclear reactors do not produce the high gas temperatures necessary to ionize thermally the seeded working fluid. However, small-scale experiments have shown that nonthermal ionization is possible under certain conditions and can result in plasma conductivities high enough to produce power in an MHD generator. In addition, nuclear reactors can be designed to yield higher gas temperatures. Some experimental devices that have been developed to study high-temperature plasmas at the Avco-Everett Research Lab are described. The Magnetic Annular Shock Tube (MAST) has been the primary tool for these investigations. Another experimental tool for studying collisionless plasmas is the Magnetic Annular Arc Accelerator (MAARC), which has been developed into a plasma wind-tunnel facility that can simulate many features of the interplanetary plasma and the solar wind. The MAARC is an electric arc jet to which a magnetic-field coil is added in such a way as to produce additional acceleration to the arc-heated plasma. The resulting MHD forces acting on the plasma accelerate the flow without increasing the plasma temperature; thereby, more directed energy is imparted to the plasma flow than would be possible through use of an arc jet alone. (BBB)

15095 INVESTIGATION OF THE ENERGY OF CHARGED PARTICLES LEAVING MAGNETIC TRAPS AFTER HIGH-FREQUENCY HEATING. Nazarov, N. I.; Ermakov, A. I.; Tolok, V. T. pp 5-9 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

The results are described of measurements of the energy of ions and electrons which are moving along the magnetic field. The heating mechanisms used in the experiments were collective excitations by ion cyclotron and fast magnetosonic waves. The characteristic waves in the plasma were excited by the spatially periodic electromagnetic fields with 10-MHz frequency. The generator power used was at the 300 kW level. The particle energy and composition was measured by the electrostatic analyzer and multigrid probes. The plasma temperature was determined by spectroscopic methods. Plasma density was determined by a microwave interferometer. It was found that three types of ions flowed out, namely, H_1^+, H_2^+, H_3^+, all of which had the same energy even though the resonant acceleration condition is satisfied for H_1^+ only. The ion temperature of 2 keV was reached, while the electron energy was only 30 eV. This also indicates the presence of three types of ions. In magnetosonic wave heating, both ions and electrons were found to reach a temperature of 150 eV. The various measuring methods gave consistent results. (ATD)

15096 MEASUREMENT OF THE PERPENDICULAR COMPONENT OF ENERGY AND THE TIME OF PLASMA BREAKUP IN HIGH-FREQUENCY HEATING. Nazarov, N. I.; Ermakov, A. I.; Tolok, V. T. pp 10-14 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

The heating by high-frequency generators and the breakup of plasma is studied by making use of the dependence of the plasma diamagnetism on the perpendicular component of particle energy. The method of measuring the diamagnetism consists of determining the magnetic field in the plasma and comparing it with the external field. The measurements were made on an experimental apparatus which used either a strong ion cyclotron wave or fast magnetosonic wave for plasma heating. The results showing the ion temperature as a function of a ratio of the external magnetic field to the plasma field (at which the gyrofrequency is 10 MHz) indicate the maximum temperature of 10 keV during the resonant excitation of the ion cyclotron wave. The density was 10^{13} electrons/cm^3. The expected cooling time of the ions was observed to be reduced by a factor of ten down to 10 μsec owing to energy transfer to colder electrons and to charge-transfer collisions in the region of the cold plasma boundary found near the plasma vessel walls. It is suggested that removal of the walls would permit considerably higher heating of the plasma. (ATD)

15097 DISSIPATION OF PLASMA OSCILLATIONS EXCITED IN A CURRENT-CARRYING PLASMA. Sukhomlin, E. A.; Suprunenko, V. A.; Reva, N. I.; Tolok, V. T. pp 126-33 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

The heating and containment of plasma in a strong magnetic field in the presence of instabilities caused by "run-away" electrons is investigated. The experiment consists of a 100 kA linear discharge in hydrogen, characterized by the absence of gross hydrodynamic instabilities. The "run-away" current was monitored to study the onset of two-stream instability and the resultant thermalization of the plasma. In the absence of collisions the anomalous diffusion observed is attributed to an increase in the kinetic pressure of electrons in the center of the discharge. This effect was used to estimate the electron temperature from the time of arrival of the expanding plasma at the tube wall. The heating time, measured by observation of the emitted x-radiation and intense microwave bursts, is much shorter than that which can be explained by collisional heating. The very high final temperature of the electrons (2 keV) and short heating time correspond to the postulated collective process of heating by a two-stream instability. (ATD)

15098 HIGH-FREQUENCY HEATING OF PLASMA. Stepanov, K. N. pp 38-59 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

A short review of high-frequency collisionless methods for heating plasma to thermonuclear temperatures is given and a comparison with ohmic heating is made; an exhaustive bibliography of theoretical and experimental works is included. The methods reviewed in detail are: (1) Cherenkov heating of ions, (2) Cherenkov heating of electrons by magnetoacoustic waves, (3) cyclotron absorption of magnetoacoustic waves, (4) ion cyclotron resonance and Alfven's wave absorption. Heating rates for these processes are given and compared with the containment times needed to achieve sufficiently high temperature of the ions (50 keV) for the thermonuclear reactions to occur. It is shown that Cherenkov and cyclotron heating with weak fields is the same as ohmic heating if the distribution function for equilibrium is reached through collisions. Furthermore, the heating periods are smaller than containment times for machines with positive energy balance. In cases where electric fields subcritical with respect to the runaway criteria are used, it is best to use higher densities since the critical field values are higher and the heating rates are greater. (ATD)

15099 ABSORPTION OF HIGH-FREQUENCY ENERGY BY PLASMA IN THE ION CYCLOTRON RESONANCE IN STRONG HIGH-FREQUENCY FIELDS. Chechkin, V. V.; Vasil'ev, M. P.; Grigor'ev, L. I.; Smerdov, B. I. pp 15-26 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

A study was made of the absorption of high-frequency waves by a plasma in the ion cyclotron resonance. The conditions for heating of plasma by this method and the physical processes which occur in various regimes are briefly reviewed. The nature of energy absorption is studied in the experiment with a high-frequency wave applied to the plasma with a density of 10^{13} electrons/cm^3 and an axial current flow of 30 A/cm^2. It is shown that the absorption of the wave depends on the interaction between ions and electrons of the plasma. This result is described by equations derived for the case of absorption by collisions. In the experiments where the electric field of the wave exceeded the critical value (which determines the maximum absorption for two-body collisions), the effective collision frequency increased strongly. This increase is attributed to the deceleration of the directed ion beam in the cyclotron wave by high-frequency plasma oscillations induced by ion beams with velocities exceeding the thermal velocity of the plasma. The experimentally determined effective collision frequency is within an order of magnitude of that arising from the above mechanism. (ATD)

15100 ANOMALOUS DIFFUSION ARISING FROM DRIFT INSTABILITY IN A CYLINDRICAL PLASMA. Matsumoto, Michio (Tokyo Inst. of Tech.). J. Phys. Soc. Jap., 22: 292-300(Jan. 1967).

A cylinder of collision-free plasma in a strong, uniform magnetic field parallel to its axis is studied theoretically. A plasma of cylindrical symmetry in equilibrium is assumed to have a current due to the electron velocity distribution of a shifted Maxwellian type. Drift instability is discussed for the density profile $n(r) = N_0(1-r^2/a^2)$, N_0 being the density on the axis. The drift waves are shown to grow to form a nonlinear equilibrium spectrum and to generate an anomalous diffusion, whose coefficient is about one-tenth of Bohm's in magnitude. (auth)

15101 FAST 120-kV Z-PINCH FOR PREIONIZATION IN SMALL INITIAL DENSITIES. Schumacher, U.; Wilhelm, R. (Institut fuer Plasmaphysik GmbH, Garching, Ger.). 7p. (In German). (CONF-660448-5). DTIE.

From Meeting of the Professional Group on Plasma and Gas Discharge Physics, Kiel.

The characteristics of a fast 120-kV Z pinch for preionization at small initial densities are described. The kinetic energy of the implosion phase was calculated for three different initial states. The current curves obtained are illustrated. The radial electron density distribution at various time points is graphed. The electron temperature was calculated. (J.S.R.)

Diagnostics of Plasma

Refer also to abstracts 14508 and 15139.

15102 (ARL-66-0143) ELECTRON-HEAVY PARTICLE NONEQUILIBRIUM IN A DENSE ARGON PLASMA. Jacobs, Paul F.; Grey, Jerry (Princeton Univ., N. J.). July 1966. Contract AF 33(657)-9962. 187p. CFSTI $3.00 cy, $0.65 mn.

An analytical and experimental study of the degree of electron–heavy particle thermal nonequilibrium in an atmospheric pressure argon arcjet is presented. An energy balance is written for the electrons, and the degree of nonequilibrium (defined as the difference between electron and heavy-particle temperatures) is expressed in terms of thermal gradients and electrostatic potential gradients. The resulting differential equation contains a strongly varying coefficient and leads, in a natural manner, to the adoption of a simple criteria for impending "freezing" of the electron temperature. The analysis indicates that the high-temperature subsonic plasma is initially very close to equilibrium, but at some critical value the electron temperature and particle density will tend to freeze. The dependence of the critical temperature upon pressure, characteristic length, atomic species, cross sections, and flow velocity is given explicitly. Numerical estimates for the degree of electron–heavy particle thermal nonequilibrium are presented for the particular case in question. (auth)

15103 (CONF-660221–, pp 372-5) PULSE PROBE MEASUREMENTS OF GAS DISCHARGE PLASMAS. Bose, D. K.; Majumdar, N. K.; Nagchaudhuri, B. D.; Sengupta, S. N.; Majumdar, S. K. (Saha Inst. of Nuclear Physics, Calcutta (India)).

A pulsed method was developed to measure the usual plasma parameters. A technique of simultaneous extraction of electrons and ions from a Duoplasmatron was also developed. The pulse method consists of applying triangular pulses to the probe, which is biased negatively and recording the resulting current-voltage characteristics with an oscilloscope. Data taken from PIG discharges and the Duoplasmatron are presented. (M.O.W.)

15104 (CONF-660221–, pp 376-80) RF STUDY OF PENNING PLASMA. Basu, J.; Dutta, C.; Sengupta, S. N. (Saha Inst. of Nuclear Physics, Calcutta (India)).

A Penning plasma was investigated using a r-f resonance probe technique in the frequency range 0.5 to 30 Mc. It appears that the characteristic curve may be interpreted to give information about a special feature of the Penning plasma, namely, a regular oscillation or rotation of electrons through the plasma. The results are described. (M.O.W.)

15105 (NP-16554) OITICHESKAYA INTERFEROMETRIYA PLAZMY. (Optical Interferometry of Plasma). Dolgov-Savel'ev, G. G.; Kruglyakov, E. P.; Malinovskii, V. K.; Fedorov, V. M. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). 1966. 15p. (In Russian). Dep. mn.

The applicability of optical interferometric methods to the study of plasma is based on the known correlation between the dielectric permeability and the concentration of electrons in the direction of the propagation of the light. If the cross section is known, the mean electron concentration may be obtained. It is also possible to determine the degree of ionization of the plasma by measuring the index of refraction of the neutral gas far from the resonance lines. Quantum generators are usually employed as the light source; in this study, ruby and neodymium glass lasers were used. The lowest electron concentration level that may be detected with an Ach–Zender type interferometer is about 10^{14} cm^{-3} at a plasma length of 10 cm; this sensitivity may be doubled by using a Michelson-type interferometer. (TTT)

15106 (UCRL-17177) ATOMIC-DENSITY MEASUREMENTS IN A DECAYING HIGHLY IONIZED HYDROGEN PLASMA. Forman, Peter Russell (California Univ., Berkeley. Lawrence Radiation Lab.). Oct. 31, 1966. Contract W-7405-eng-48. 77p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

Atomic-density measurements in a decaying, dense, highly ionized hydrogen plasma have been performed by a vacuum uv-absorption technique. Light of wavelength 890.8 Å is shone through the plasma, and its attenuation, caused by photoionization of the hydrogen atoms present, is measured. The plasma is formed in a copper cylinder 86.4 cm long with a radius of 7.3 cm. In the interior, the initially highly ionized plasma, which has an ion den-

sity of 4.9×10^{15} ions/cc and a temperature of about 1 eV, is found to decay by three-body volume recombination. Its atomic density is observed to increase in time at the correct rate, which confirms the earlier notion that this part of the plasma indeed recombines in situ, and remains near Saha equilibrium for up to 200 μsec. During the formation of the plasma, apparently a layer of atoms is formed near the cylinder wall. This layer has been detected and observed to relax in a time consistent with diffusion inward due to charge-exchange collisions with the ions of the plasma. The energy loss in the interior regions of this plasma is observed to be at a rate considerably in excess of that expected from normal thermal conductivity or even from anomalous diffusion of ions. (auth)

15107 PLASMA DENSITY MEASUREMENT BY MOLECULAR ION BREAKUP. Hickok, R. L. (Mobil Oil Corp., Princeton, N. J.). Rev. Sci. Instrum., 38: 142-3(Jan. 1967).

A technique is described for using the collisional dissociation of an energetic molecular ion beam for measuring the relative density distribution of a magnetically confined plasma. The advantages of this technique are outlined. A 1.8-MeV H_2^+ beam was used to measure the radial density distribution of a magnetically confined, energetic deuterium arc. (M.O.W.)

15108 SOME SPECTRAL CHARACTERISTICS OF ELECTRODELESS RING DISCHARGE. Klement'ev, V. M. Zh. Prikl. Spektrosk., Akad. Nauk BSSR, 5: 701-5(Dec. 1966). (In Russian).

The ring discharge characteristics in long cylindrical tubes of different cross sections are studied by the intensity behavior of xenon ion lines (Xe II, $\lambda = 4844$Å) depending on the discharge parameters. The mean electron temperature in the ring discharge is determined by the ratio of the helium line intensities. The influence of helium admixture on the intensity of Ne line with $\lambda = 6328$Å is studied. (auth)

15109 APPLICATION OF MICROWAVES IN PLASMA MEASUREMENTS. Azuma, Seizo; Oguchi, Tadashi (Hitachi Electronics Co., Ltd., Japan). Hitachi Hyoron, 48: No. 5, 81-5(May 1966). (In Japanese).

The basic characteristics of a plasma was measured by the microwave technique. A 50-Gc-band apparatus with a thin-beam antenna was constructed for the measurement of the electron density, collision number, and electron temperature of a plasma. The energies of the blackbody radiation, bremsstrahlung, and cyclotron radiation, caused by the plasma could also be measured by this apparatus. It consists of a hf detector with a local oscillator, a main if amplifier, a standard 2nd detector with klystron power supply, and a reference discharge lamp for the calibration of the noise level of the apparatus. Compared with the conventional electromagnetic horn, the thin-beam antenna consisting of an elliptic parabola has the following advantages: detailed measurements of the local properties of a plasma, high sensitivities in the measurements, and the fine adjustment in the resolving powers. (NSA of Japan)

15110 DISCHARGE MEASUREMENTS BY THE PROBE TECHNIQUE. II. PROBE MEASUREMENTS OF NONSTATIONARY DISCHARGES AND OF DISCHARGES IN AN EXTERNAL MAGNETIC FIELD. Bito, Janos (Industrial Research Inst. for Communications Technology, Budapest). Magyar Fiz. Foly., 14: 297-316(1966). (In Hungarian).

Following previous paper on probe methods for stationary discharges, the problems encountered in the study of periodic and nonstationary discharges in the plasma are reviewed. Applicability of a given method depends on the prevailing conditions. An important criterion for the selection of the most suitable method is the periodicity, or time dependence, of the process. If the probe tension changes so rapidly that the probe current cannot follow it through equilibrium states, the shape of the characteristic curve of the probe will not yield any real information on the monetary state of the discharge space; therefore, the measurements must be taken at several quasistationary states. On the basis of the ac distribution function of Emelius, the dc probe technique of Nolle is derived, indicating the conditions, under which it may be applied to nonstationary discharges. The Ledrus-type plasmograph which may be used for the study of periodic plasmas, and the Fait–Koncz and the Waymouth methods are briefly examined. The microwave probe technique is also quite useful in some cases. Special methods are required to determine the magnetic field of the discharges. The widespread use of the probe techniques is due to their easy and rapid operation. Presence of a foreign body, the probe, in the system is a disturbance that must be taken into account but even so, the probe technique represents the best method for studying discharges and cold plasmas. (TTT)

15111 ELECTROSTATIC SHEATH IN A WEAKLY IONIZED GAS. Bienkowski, G. K. (Princeton Univ., N. J.). Phys. Fluids, 10: 381-91(Feb. 1967).

The behavior of a thin electrostatic sheath adjacent to a body immersed in a flowing weakly ionized gas is analyzed on the basis of kinetic theory using a moment method. The study is confined to the regime of mean free path and Debye length small compared to body size but for arbitrary ratios between them. When the mean free path is the smallest parameter, the solution reduces to the continuum solution with a thin "Knudsen layer" at the body. In the opposite limit of smallest Debye length, a departure in the potential drop from that in the continuum regime occurs within the quasi-neutral solution. The point at which this solution terminates can be interpreted as a sonic point for the attracted particles. There is then a thin transitional layer, followed by a free-fall sheath. The case of negative potential is analyzed in detail, and the current–voltage characteristics are obtained in an explicit form. (auth)

15112 DETERMINATION OF DENSITY DISTRIBUTION AND TEMPERATURE OF PLASMA USING REFRACTION AND ATTENUATION OF THE BEAM. Sizonenko, V. L.; Stepanov, K. N. pp 109-17 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

Propagation of a microwave beam through a nonhomogeneous plasma is considered as a diagnostic method for determination of the density distribution and electron temperature in the plasma. Fermat's principle is employed to obtain a general expression for the trajectory of the beam in a refracting medium as a function of frequency and angle of incidence. Detailed computation for the case of semi-infinite plasma is considered and the distance between points of beam entry and exit is found, as well as the inverse relationship for the density coordinates. This approach is extended to a laboratory plasma of cylindrical geometry. The temperature of the plasma electrons is shown to be obtainable by observing the beam attenuation. The coefficient of attenuation as a function of radius is derived for the plasma with electron–ion and electron–neutral collision frequencies lower than beam frequency. (ATD)

15113 PLASMA DIAGNOSTICS USING ELECTROSTATIC PROBES UNDER SHORT MEAN FREE PATH CONDITIONS. Weissman, D. E.; Scharfman, W. E.; Guthart, H. (Stanford Research Inst., Menlo Park, Calif.). Phys. Fluids, 10: 464-6 (Feb. 1967).

The properties of a medium pressure plasma were inferred from electrostatic probe measurements using the theory of Zakharova et al. The results were compared with microwave measurements and the agreement was within a factor of 3. (auth)

15114 A STUDY OF THE MAGNETO-KERR AND OTHER EFFECTS AT A PLASMA SURFACE. Robinson, L. C. (Univ. of Sydney). Austral. J. Phys., 20: 29-46(Feb. 1967).

The role of microwave reflection observations and particularly the magneto-microwave Kerr effect in the study of plasma surface phenomena is discussed. The method makes possible the absolute measurement of high electron surface densities in a density region not readily accessible to other experimental techniques, and it gives an indication of the collision frequency for momentum transfer. To facilitate the interpretation of measurements in terms of plasma parameters, curves are computed for a step-function plasma profile giving the dependence of reflection on surface electron density and collision frequency over a wide range of magnetic induction fields and microwave frequencies. The results are directly applicable to the three microwave frequencies commonly used in plasma physics research, namely 10, 35, and 120 Gc. From an analysis of the dependence of the magnitudes and phases of the reflection coefficients of circularly and linearly polarized incident waves, the relative value of the various possible waves and combinations of waves for plasma diagnostic experiments is assessed. The effects of variations from a step-function plasma density profile are considered. Polynomial expressions are derived giving the factor by which the amplitudes and phases of the reflection coefficients are modified when the density rises exponentially to a plateau level, and this factor is computed for steep gradients. (auth)

15115 LONGITUDINAL DIELECTRIC CONSTANT IN A MULTI-COMPONENT PLASMA. Sips, Vladimir (Ruder Boskovic Inst., Zagreb). Glas. Mat.-Fiz. Astron., Ser. II, 20: 261-9 (1965).

Based on simple concepts, a treatment for the evaluation of the longitudinal dielectric constant in an N-component homogeneous plasma is presented. The results obtained are applied to a classical gas plasma, for which the dielectric constant, the resonant frequencies of the plasma, and the interaction coefficients are calculated. (auth)

15116 THE PROFILES OF BALMER AND PASCHEN LINES OF ATOMIC HYDROGEN: A COMPARISON BETWEEN THEORY AND EXPERIMENT. Pfennig, Hans (Max-Planck-Institut fuer

Physik und Astrophysik, Muenchen, Ger.). Z. Naturforsch., 21a: 1648-59(Oct. 1966). (In German).

The profiles of the Balmer and Paschen lines of hydrogen being emitted from a plasma of relatively low electron-density and temperature ($N_e = 1.3 \times 10^{13}$ cm^{-3}, T = 1850°K) are compared with theoretical profiles based on a quasistatic treatment of the ions and electrons. For a region extending from the line wing to a point lying well inside of Holstein's frequency limit a satisfactory agreement with experiment can be achieved by using Ecker's microfield-distribution folded with itself and by inserting values of the parameter r_0/λ ($r_0 \approx$ mean particle distance λ = Debye length) being roughly twice as high as one would calculate from the values of N_e and T. Within the framework of the quasistatic theory there seems to be no way of explaining the discrepancy between the high value of r_0/λ which fits the experimental curves best and the theoretical value which is lower by a factor of about 2. (auth)

15117 PROPOSAL FOR A NONLINEAR SCATTERING EXPERIMENT. Kuepper, F. P. (FOM-Instituut voor Plasma-Fysica, Rijnhuizen, Netherlands). Physica, 32: 1825-7(Oct. 1966).

The main difficulty in a nonlinear scattering experiment in a plasma using two laser beams of slightly different frequencies, lies in the fact that plasma oscillations will occur only with relatively high amplitudes if the frequency difference $\Delta\omega_1 = \omega_{11} - \omega_{12}$ of the two laser beams is equal to the electron plasma frequency ω_p. As ω_p is a function of time in transient plasmas, $\Delta\omega_1$ should vary rapidly as compared to the rate of plasma density change. An arrangement is suggested which will produce a time variation of the frequency shift $d/dt\ \Delta\omega_1$ over more than two orders of magnitude within 10 nsec. (W.D.M.)

15118 APPLICATION OF MASS SPECTROMETRY TO THE STUDY OF GASEOUS PLASMAS. Mosharrafa, M.; Oskam, H. J. (Univ. of Minnesota, Minneapolis). Contracts Nonr 710(37); AF 19(628)-4794. Physica, 32: 1759-65(Oct. 1966).

A survey of the main desirable characteristics of a mass spectrometer for studies on plasma ionic constituents is reported. These considerations have led to the choice of the quadrupole mass spectrometer as being the most suitable type to be used. It is shown that isotopic techniques applied to the studies of the ionic structure of gaseous plasma can be a very useful and important tool for obtaining correct identification of monatomic and polyatomic ion species existing in the plasma. (auth)

15119 SPECTROSCOPIC METHOD FOR MEASURING THE ELECTRON TEMPERATURE OF A PLASMA. Wilner, Bertil (Royal Inst. of Tech., Stockholm). Acta Polytech. Scand., Phys. Nucl. Ser. No. 41, 1-45(1966).

The derivation of the electron temperature of a plasma from measured spectral-line intensities is discussed for a wide temperature and density region. The theory is based on a simple analysis of different types of excitation and ionization equilibria as well as their relaxation times. Special consideration is given to the influence of step-wise processes or a non-Maxwellian electron-velocity distribution. The results are illustrated in a number of diagrams. (auth)

15120 ELECTROMAGNETIC WAVE INTERACTION IN AN INHOMOGENEOUS DRIFTING PLASMA. Mehuron, William Otto. Philadelphia, Univ. of Pennsylvania, 1966. 161p.

Thesis.

A theoretical model was developed with the plasma described as an active medium by including an energy exchange mechanism between the electromagnetic waves and the drifting plasma. A set of dynamical equations governing the interaction, or energy exchange mechanism, were developed and linearized by means of a suitable small-signal approximation. Plasma parameter inhomogeneities were introduced by providing the electron density and electron drift velocity with a suitable spatial variation. The problem was formulated in a circular cylindrical coordinate system and the plasma was assumed to be inhomogeneous in the radial dimension. This formulation leads one to a set of equations for the longitudinal components of the electric and magnetic field intensities for the inhomogeneous drifting plasma. Methods of solution of the equations for the longitudinal components of the field variables in the plasma, the surrounding dielectric, and free-space regions are considered. Generalized dispersion relations are developed for the cases of the inhomogeneous drifting plasma column in free space, within a thin-walled dielectric tube, and within a helix microwave guiding structure. The appropriate boundary conditions for the systems were utilized to obtain the general forms of the dispersion relations. In the case where a microwave guiding structure is present, a sheath model of the helix was used. Numerical evaluation of the dispersion relations for the homogeneous plasma and a wide range of typical plasma inhomogeneities were carried out using a digital computer program that was developed and written for this purpose. The computer program obtains the solutions of the dispersion relations that are expressed in the form of Nth degree polynomial equations. The experimental program consisted of measuring the dispersion curves for the helix-plasma system and the electron drift velocity of the plasma. The experimental results were obtained by using the positive column of a low pressure discharge in argon. The discharge could be operated in a continuous or pulsed fashion for studies in the afterglow of the discharge where the plasma inhomogeneities tend to become less pronounced. Comparison of the experimental results and the predictions obtained from the theoretical model are presented and indicate good agreement. Estimates of the electron collision frequency were also obtained from the measurements of the electron drift velocity and a knowledge of the electric field strength along the positive column of the glow discharge. (Dissertation Abstr.)

15121 LANGMUIR PROBE INVESTIGATION OF A GLOW DISCHARGE WITH A TRANSVERSE MAGNETIC FIELD. Cook, Charles Stanton. Rochester, N. Y., Univ. of Rochester, 1966. 257p.

Thesis.

An abnormal argon glow discharge was investigated in the presence of a transverse magnetic field for field strengths ranging from 0 to 600 G using spherical Langmuir probes to obtain the spatial variation of plasma potential, electron temperature, and ion number density as functions of magnetic field strength. A theory is presented showing that for approximately 30 or fever collisions in the sheath, standard spherical Langmuir probe theory is appropriate for computing the ion space charge sheath size around the negative probe. Further theory is presented demonstrating the appropriate expression for the ion current density at the sheath edge as a function of the number of collisions in the sheath. Finally Schulz and Brown's treatment of mobility controlled ion collection by a negative cylindrical probe is extended to the spherical case. The probe theory presented was verified experimentally using spherical copper Langmuir probes with sphere diameters ranging from 0.0075 inches to 0.020 inches. (TSS)

15122 DETERMINATION OF ELECTRON DENSITY DISTRIBUTION IN PLASMA-FILLED MICROWAVE CAVITIES. Stark, Peter Gabriel. Syracuse, N. Y., Syracuse Univ., 1966. 80p.

Thesis.

A method is presented for determination of electron density profiles in microwave cavities. This method is based on measurements of resonant frequency shifts of several resonant modes of the cavity from their values when there is no plasma in the cavity to their values with plasma present. The shifts are related by a system of linear equations to the coefficients of a spatial Fourier expansion of the electron density in the cavity. The solution of this system of equations yields the density in terms of its Fourier expansion. An application of this method for the case of a steady-state microwave discharge in a cavity is discussed. The density profile is determined and results are corroborated by independent density measurements with Langmuir probes. The resonance phenomena of a microwave cavity filled with plasma, which is produced by the microwave electric field are also studied. Resonance curves are computed and plotted for several values of collision and cyclotron frequencies and applied power. It is shown how these results can be employed to determine the average electron density of plasma. A qualitative, physical explanation of the resonance phenomena is discussed and experimental resonant curves are shown to be in good agreement with theoretical predictions. (Dissertation Abstr.)

15123 RESONANT CAVITY MEASUREMENTS OF IONIZED WAKES. Kornegay, Wade M. (Massachusetts Inst. of Tech., Lexington). 11p. (CONF-660823-2). DTIE. Gmelin, AED-CONF-66-261-5.

From 2nd International Congress of Instrumentation in Aerospace, Stanford, Calif.

A transmission resonant cavity technique, which is suitable for making measurements of electron line densities and collision frequencies in the ionized wakes of hypervelocity projectiles, is described. With this method electron density measurements can be made over six orders of magnitude. Resonant cavity design requirements and limitations of the method are discussed. Typical data from measurements behind projectiles traveling at speeds up to 6.5 km/sec are given. (auth)

15124 EXPERIMENTAL STUDIES OF PLASMA SHEATH SURROUNDING MODELS IN HOT-SHOT WIND-TUNNELS. Dorey, Jacques; Compard, Didier (Office National d'Etudes et de Recherches Aerospatiales, Chatillon, France). 11p. (CONF-660823-1). DTIE. Gmelin, AED-CONF-66-261-1.

From 2nd International Congress of Instrumentation in Aerospace, Stanford, Calif.

Nitrogen flow characteristics around models are investigated in view of obtaining data which determine the physical state of the plasma. Among all possible techniques, the most adaptable to the special hot-shot conditions (electrostatic probes and vhf microwave reflectometry) were chosen. Experimental apparatus and the results in nitrogen are described. The ionization is not homogeneous during the shot; this result seems to confirm the assumption that the plasma flow is utilizable only after a delay of several tens of milliseconds following the shock formation period. Possibilities for using hot shots to produce hypersonic plasmas around models are deduced. (auth)

15125 INTERFEROMETRIC VELOCITY MEASUREMENTS ON PLASMA BEAMS. Beth, M.-U.; Nedder, G.; Bohn, W. L. (DVL-Institut fuer Plasmadynamik, Stuttgart). 9p. (In German). (CONF-660448-1). DTIE.

From Meeting of the Professional Group on Plasma and Gas Discharge Physics, Kiel.

The velocity of a plasma beam was determined by use of the Doppler displacement. The optical arrangement of the interparameter was given. The diagrams obtained were evaluated by photometry and measurement of the side-on and oblique-on ring system. The integrated displacement profile was measured from suitable isolated lines. The gas temperature and the electron temperature patterns were determined. (J.S.R.)

Kinetics of Plasma

Refer also to abstracts 14509, 14991, and 15099.

15126 (IPP-2/53) RADIATION OF HARMONICS $n\omega_e$ AND $n(\omega_e/2)$ FROM A BEAM-GENERATED PLASMA. Landauer, G.; Mueller, G. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Oct. 1966. 18p. (IPP-3/46; CONF-661041-1). Dep. mn.

From 1st European Conference on Controlled Fusion and Plasma Physics, Munich, Germany.

A short account of an experimental study on radiation from a beam-generated plasma in helium is given. Radiation at the harmonics of the electron cyclotron frequency ω_e and at half the electron cyclotron frequency $\omega_e/2$ was only found when a metallic probe was present in the beam. Both modes of these two emission spectra could be observed under characteristic experimental conditions. These conditions enable one to draw conclusions on the plasma state in which emission occurs at frequencies $\omega = n\omega_e$ or $\omega = n\omega_e/2$. (auth)

15127 (JPL-TR-32-888) ANALYSIS AND APPLICATION OF THE DIELECTRIC CONSTANT OF A TWO-TEMPERATURE PLASMA. Klevans, E. H.; Primack, J. R. (Jet Propulsion Lab., Pasadena, Calif.). Feb. 1, 1967. Contract NAS7-100. 46p.

A discussion is presented of three problems which arise in the study of fully ionized plasmas where the electron temperature exceeds the ion temperature. In the first problem, the dielectric constant of a two-temperature plasma is analyzed to determine (1) the conditions under which ion waves will be found, (2) accurate values for the phase velocity and damping rate of ion waves, (3) the validity of approximate expressions for the ion wave phase velocity and damping, and (4) the behavior of the dynamic shielding factor when ion waves are possible. The second problem concerns the numerical evaluation of the high frequency conductivity of a two-temperature plasma. Approximations, and their validity, are discussed. Results are presented for the real part of the conductivity as a function of frequency with the electron-to-ion temperature ratio as a parameter. For the third problem, the electrostatic energy per degree of freedom is computed. A comparison is made of numerical results obtained from approximate analytic expressions with those obtained from numerical integration of the exact expression. (auth)

15128 (N-66-36073) UNIFIED TREATMENT OF THE RELAXATION PHENOMENON IN RADIATING ARGON PLASMA FLOWS BEHIND INCIDENT AND BAD SHOCK WAVES. Oettinger, Peter E. (Stanford Univ., Calif. Dept. of Aeronautics and Astronautics). July 1966. 123p. (NASA-CR-77861). CFSTI $3.00 cy, $0.65 mn.

The electronic relaxation of a shock heated, nonequilibrium argon plasma flow is treated by means of a combined theoretical and experimental investigation. A physical model of the flow is postulated which includes the microscopic collisional and radiative processes. When coupled with the macroscopic conservation laws, this leads to a rigorous formulation of the equations governing the relaxing flow. A resultant numerical solution for the flow behind a strong incident shock front propagating into argon gas is compared to time-resolved interferograms. Good agreement is obtained between theory and experiment for incident shock Mach numbers of 11 to 18 propagating into argon at pressures of 3 to 5 mm Hg. The experimental investigation is extended into the argon shock layer preceding a cylinder-plate. An attempt is made to use the formulated equations to predict conditions along the stagnation streamline, when the flow can either be considered one-dimensional or at constant density across most of the shock layer. Comparison of the experimental and theoretical results shows that neither one of these postulated flows actually exists. (auth)

15129 (NP-16478) ELECTRIC FIELD PARALLEL TO THE MAGNETIC FIELD IN A LOW-DENSITY PLASMA. Persson, Hans (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). Feb. 10, 1967. 20p. Dep. mn.

A collisionless plasma in an inhomogeneous magnetic field was investigated. The principle of quasineutrality and the assumption that the particles move without collisions is shown to imply that in general there is a significant electric field parallel to the magnetic field. Brief applications to the magnetosphere and to a laboratory experiment devoted to a study of the parallel electric field are discussed. (M.O.W.)

15130 (NP-16548) HARMONIC GENERATION USING THE VARACTOR CAPABILITIES OF THE PLASMA SHEATH. Holmes, R. A.; Hilbish, R. T. (Purdue Univ., Lafayette, Ind. School of Electrical Engineering). Dec. 1966. Contract N00016-66-C0076-A04. 141p. (TR-EE-66-23).

A study is made of large-signal, high-frequency phenomena occurring in a slightly ionized plasma contained within a set of concentric, metallic coaxial cylinders. The frequency is constrained to lie between the ion and electron plasma frequencies. From a time-independent numerical solution of the Tonks and Langmuir "complete plasma-sheath equation," sheath, presheath, and plasma regions are defined based upon the relative electron and ion density profiles between the coaxial cylinders. From a quasi-static analysis, an rf equivalent circuit is developed wherein the sheath is represented by a voltage dependent capacitor in parallel with a voltage dependent resistor and the presheath by a "collisionless" loss element. From a separate small signal analysis it is shown that the plasma region can be represented by a series resistor and inductor. It is found that when the sheath is thin compared to the radius of the inner cylinder, the voltage dependence of the sheath capacitor reduces to a form identical with that of an abrupt junction varactor diode, so that the plasma capacitor is properly called a plasma varactor. The validity of the equivalent circuit is experimentally verified by comparing current waveforms as predicted by the equivalent circuit and as obtained experimentally with an rf voltage driving a mercury vapor discharge plasma contained within the required coaxial geometry. The plasma is characterized by a pressure of approximately 6.5×10^{-2} mm Hg and electron density near $10^{17}/m^3$. Excellent agreement of the current waveforms is noted over a wide range of dc bias and rf driving conditions. As an application of the plasma varactor, frequency doubling using standard semiconductor varactor techniques is attempted. The resultant peak conversion efficiency is found to be 31.6% at a drive frequency of 142 Mc and input power of .42 W. It is shown that the sheath conductance is responsible for this low conversion efficiency relative to that obtainable from a semiconductor varactor, and it is suggested that the use of a lower-temperature discharge plasma, such as cesium, should result in a substantial improvement. (auth)

15131 (ORNL-P-2827) ELECTRON-TEMPERATURE VARIATION INDUCED EFFECTS AND LANDAU DAMPING OF ION-ACOUSTIC WAVES. Alexeff, I.; Jones, W. D. (Oak Ridge National Lab., Tenn.); Montgomery, David (Iowa Univ., Iowa City). [1966]. Contract W-7405-eng-26. 28p. (CONF-670104-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Conference on Physics of Quiescent Plasmas, Frascati, Italy.

Quiescent plasmas were produced in a very simple spherical discharge tube. Ion acoustic waves were propagated in these plasmas. The velocity of the waves were observed as a function of the electron temperature. Both the ion temperature contribution to the wave velocity and the onset of Landau damping as the electron temperature is reduced was observed. As a second demonstration of the Landau damping, a light contaminant was added to the plasma and damping was observed without changing the bulk properties of the plasma. As a by-product of this study, a simple device was developed for producing a quiescent plasma in which the electron temperature can be varied over a very wide range. (M.O.W.)

15132 CYCLOTRON RESONANCE IN AN INCLINED MAGNETIC FIELD. Azbel, M. Ya.; Peschanskii, V. G. (Inst. of Theoretical Physics, Academy of Sciences, USSR). JETP Lett. (USSR)(Engl. Transl.), 5: 19-21(Jan. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 26-9(Jan. 1, 1967).

Earlier experimental studies were performed on the observa-

tion of cyclotron resonance in a constant magnetic field H inclined at an angle to the surface of the metal. A theory is discussed for resonance at arbitrary angles of inclination, when there is no resonance in the principle approximation in terms of the anomaly. (M.O.W.)

15133 TRAVERSAL OF A POTENTIAL UHF BARRIER BY A WEAKLY INHOMOGENEOUS PLASMA BEAM. Sergeichev, K. F. Zh. Eksp. Teor. Fiz., 52: 575-83(Feb. 1967). (In Russian).

The interaction between a cylindrical plasma jet moving across a circular wave guide and the field of a traveling linear polarized H_{11} is studied. It is shown that for the jet of a rarefied, weakly inhomogeneous plasma the motion of the beam near the axis is determined by reflection in the force field on the one-dimensional potential uhf barrier. It is found that increase of the plasma particle density up to a certain critical value results in strong disturbance of the plasma jet motion. The disturbance is developed when the density changes by 10 to 20%. (auth)

15134 THEORY OF THE FERMI STATISTICAL ACCELERATION. Tverskoi, B. A. Zh. Eksp. Teor. Fiz., 52: 483-97(Feb. 1967). (In Russian).

It is demonstrated that during Fermi acceleration the principle of detailed equilibrium is observed and acceleration reduces to particle diffusion in momentum space. A kinetic equation for particles accelerated in a turbulent plasma is derived, and conditions are obtained for which the effective mean free path is independent of momentum and the distribution function is isotropic. Nonstationary solutions for which losses are not taken into account are considered, and it is shown that the asymptotics of the spectra at high energies are of a universal nature. Confinement of fast particles in the turbulent region as a result of collision with waves is investigated. Possible applications of the results to the theory of particle acceleration in solar flares and in the shells of supernovae are briefly discussed. (auth)

15135 ADIABATICITY OF THE MOTION OF PLASMA BURSTS IN LONGITUDINAL MAGNETIC FIELDS. Khizhnyak, N. A.; Kalmykov, A. A.; Trubchaninov, S. A.; Naboka, V. A. Zh. Tekh. Fiz., 36: 1652-64(Sept. 1966). (In Russian).

The motion of plasma bursts along the axis of a longitudinally inhomogeneous axially symmetric magnetic field is discussed. The pliant current loop model is generalized to take into account changes in the shape of the plasma. Equations of motion are derived under the simplifying assumptions that the deformation of the plasma is small, the plasma remains spheroidal (but may become either prolate or oblate), and the thermal expansion of the plasma during its interaction with the magnetic field is negligible. Particular attention is given to the magnetic moment of the plasma burst as a criterion of the adiabaticity of its motion. The theoretical predictions were tested experimentally. Hydrogen plasma bursts from a coaxial plasma gun, after traversing a 1-m-long drift tube, entered the field of a series of six 17-cm-long, 8-cm-inner-diameter dc solenoids, each capable of producing a 10-kOe field. The magnetic moments of the plasmas were measured with the aid of an external loop and internal magnetic probes that could be adjusted in the radial direction. The densities of the plasmas were determined with a shielded electrical probe, by cutoff of 3- and 0.8-cm microwaves, and with a 3-cm-wavelength interferometer. The plasmas were found to behave in accordance with theory. In particular, the magnetic moments of the plasmas, with densities below 10^{12} cm^{-3}, remained constant until fields of the critical strength were encountered and then decreased monotonically and fairly rapidly, whereas the magnetic moments of the plasmas with densities above 10^{14} cm^{-3} increased as the plasmas moved into regions of higher field strength, even though the independent-particle adiabaticity condition was better satisfied by the high-density plasmas than by the low-density ones. It is concluded that the generalized current loop model provides a rather good approximate description of the behavior of plasma bursts. The work of several other investigators is discussed in the light of the present theory, and it is concluded that the plasma entrapment mechanism proposed by J. L. Tuck (Phys. Rev. Lett., 3: 317 (1959)) can be effective only under such conditions that the plasma traverses the magnetic field gradient region in a time shorter than the collapse time of the plasma, which is approximately the ratio of the plasma circumference to the Alfven velocity. (ATD)

15136 CHARACTERISTICS OF SEVERAL TYPES OF PLASMA ACCELERATORS. Musin, A. K. (Lenin Electrotechnical Inst., Moscow). Zh. Tekh. Fiz., 36: 1626-35(Sept. 1966). (In Russian).

Equations describing the acceleration of plasma in a rail type accelerator, in which the effects of circuit losses and the variation of the mass of the accelerated plasma are taken into account, were solved with an analog computer for a number of values of the relevant parameters, and the results are tabulated. The tables give the electrical characteristics of the circuit (the capacitance and initial charge of the capacitor bank, the maximum current, the circuit inductance, and the rate of change of inductance with position of the accelerating plasma) and the length of the accelerator required to produce plasma bursts of different velocities, masses, momenta, and energies with different energy utilization efficiencies. The tabulated data show that the production with efficiencies exceeding 50% of plasmas with velocities higher than 10^7 cm/sec imposes very rigid requirements on the electric and geometric characteristics of the accelerator, which cannot always be met with presently available techniques. Approximate analytic design formulas are presented, which do not deviate from the computer results by more than 30%. Formulas derived in earlier papers of the author for the velocity, momentum, and acceleration efficiency of plasmas accelerated in crossed field, rail, coaxial, "plasma piston," and induction accelerators are also tabulated. It is concluded that from the tabulated data one can predict the characteristics of plasmas accelerated with a given machine, and can calculate the characteristics of the accelerator required to produce plasma bursts with given properties. (ATD)

15137 DYNAMICS OF THE CURRENT SHEET AND ACCELERATION OF PLASMA IN AN ELECTRODYNAMIC RAIL ACCELERATOR. Khizhnyak, N. A.; Kalmykov, A. A. Zh. Tekh. Fiz., 36: 1608-21(Sept. 1966). (In Russian).

The production and acceleration of plasma in a rail accelerator having plane parallel electrodes are discussed. The problem is treated in one dimension, all quantities being assumed to depend only on the time and on one Cartesian coordinate, whose axis is parallel to the two electrodes and perpendicular to the electron current sheet, which is assumed to be initially present. The inertia of the electrons is neglected, and it is assumed that the electron Larmor radius is small compared with the electrode spacing. The electron motions are thus treated in the drift approximation when the plasma is rarefied, and with the effect of the Hall currents included when the plasma is dense. Ions are assumed to be formed in the current sheet and to lag behind, thus producing a longitudinal polarization field. It is shown that the form and magnitude of the polarization field play decisive roles in the shaping and acceleration of the plasma burst. To calculate the polarization field, the motion of the ions is described by the kinetic equation with a term representing the production of ions in the forward current sheet, and several simplifying assumptions are introduced, including the assumptions that the current sheet is thin and moves with constant velocity. It is shown that the polarization gives rise to longitudinal electrostatic waves in the plasma, and that as a result of these oscillations there are formed many closed current loops. An equation is derived relating the velocity of the center of mass of the plasma to that of the current sheet. The electrodynamic acceleration of the center of mass is described by equations similar to those of L. A. Artsimovich until the energy begins to be expended in the production of electrostatic oscillations. Whereas the energy of the plasma as a whole is determined by the total discharge current, the energy spectrum of the plasma particles depends significantly on the distribution of the current within the plasma. It is found that there is an optimum self-inductance for maximum acceleration efficiency, below which it is not desirable to reduce the parasitic inductance of the circuit. (ATD)

15138 FEASIBILITY OF INVESTIGATING A PINCH DISCHARGE BY USING ITS INTRINSIC STIMULATED EMISSION. Likhachev, V. M.; Rabinovich, M. S.; Sutovskii, V. M. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 5: 43-5(Jan. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 55-7(Jan. 15, 1967).

The existence of negative-temperature states in a high-temperature plasma of a strong-current pinch discharge was demonstrated earlier, where stimulated emission was generated in a plasma of such a discharge. This phenomenon was used to investigate the cumulation of a pinch discharge. The time correlation between the stimulated-emission pulse and the current pulse at the instant of discharge cumulation was measured. (M.O.W.)

15139 INTERACTION OF HIGH-FREQUENCY TRANSVERSE WAVES WITH A TURBULENT PLASMA. Kovrizhnykh, L. M. (Lebedev Inst. of Physics, Moscow). Zh. Tekh. Fiz., 36: 1585-93(Sept. 1966). (In Russian).

The nonlinear equations for a weakly turbulent plasma are used to discuss in a one-dimensional approximation the passage of high-frequency transverse electromagnetic waves through a layer of turbulent plasma of finite thickness. The incident signal is assumed to cover a narrow band of frequencies centered on a frequency F_0 that is much greater than the electron Langmuir frequency f_0 of the plasma, and the phases of the Fourier components of the incident wave are assumed to be randomly distributed. Separate treatments are given for the two cases in which F_0 is greater than, or much less than f_0/v, with $v^2 = T/m$, where T is

the electron temperature in the plasma and m is the electron mass. In the low-frequency case it is still assumed that F_0 is much greater than f_0. Both cases are characterized by the production of satellites at frequencies $F = F_0 \pm nf_0$, where n is an integer. Formulas are derived for the intensities of these satellites in terms of the parameters characterizing the turbulence of the plasma, and other relevant parameters. It is found that the satellites, as well as waves of the fundamental frequency, continue to be emitted by the plasma with decreasing intensity for a short time after the incident wave has been cut off. The low-frequency waves interact much more strongly with the plasma than do the high-frequency waves. In the high-frequency case all the satellites propagate in the direction of the incident wave, whereas in the low-frequency case the even satellites propagate in that direction and the odd ones propagate in the opposite direction. It is suggested that the formulas may be useful for diagnosis of turbulent plasmas. (ATD)

15140 INFLUENCE OF NEUTRAL GAS COOLING ON LONGITUDINAL ELECTRIC FIELD IN NEON AND HELIUM DISCHARGE. Masek, K.; Perina, V. (Inst. of Physics, Prague). Czech. J. Phys., 17: 198-201(1967).

The influence of cooling the neutral gas on the current dependence and pressure dependence of the longitudinal electric field in the positive column of a neon and helium glow discharge was subjected to experimental study. Hitherto, these dependences have been measured in the region of glow discharge without ionization waves under Pupp's limit, at a room temperature of the neutral gas. (M.O.W.)

15141 PENETRATION OF A LONGITUDINAL ELECTRIC FIELD INTO A BOUNDED MAGNETIZED PLASMA. Kondratenko, A. N. Zh. Tekh. Fiz., 36: 1724-6(Sept. 1966). (In Russian).

The penetration of an alternating electric field into an infinite slab of plasma of finite thickness in the presence of a uniform magnetic field parallel to the boundaries of the plasma is discussed. The calculations are based on Maxwell's equations and the linearized kinetic equations for small deviations of the distribution functions from their Maxwellian equilibrium forms. Specular reflection of the plasma particles at the boundaries of the plasma is assumed as boundary conditions for the distribution functions. The component of the electric field parallel to the plasma boundary is assumed to vanish on both boundaries, and the component perpendicular to the plasma boundary of the oscillating electric field is assumed to have a specified amplitude on both boundaries. A general expression is derived for the component perpendicular to the plasma boundaries of the electric field within the plasma. This expression is simplified for the special cases of low and high frequency of the electric field and low- and high-space dispersion, and expressions are obtained for the frequencies at which spatial resonance occurs. (ATD)

15142 NONLINEAR THEORY OF LOW-FREQUENCY OSCILLATIONS EXCITED BY AN ION BEAM IN A PLASMA. Lominadze, D. G.; Shevchenko, V. I. pp 164-77 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

The possibility of heating the ion component of a plasma by beam instabilities is investigated in the nonlinear approximation for the case of plasma with electron temperature much higher than that of the ions. The first phase of development of the instability is traced out and most unstable branches of the oscillation are determined. Three regimes, namely, excitation of long-wavelength, high-frequency oscillations (hydrodynamic phase), excitation of low-frequency oscillations (quasi-linear phase) and short-wavelength, low-frequency waves are investigated in detail. The change in macroscopic plasma and beam parameters (thermal energy, directed velocity) are derived. It is possible to describe the development of the instability during the quasilinear phase and determine the state reached by the plasma and the beam as a result of quasilinear relaxation when a strong magnetic field is superimposed on the plasma. In general, it is found that the beam energy is shifted to transverse energy and leads to enhanced diffusion of ions across magnetic field lines. (ATD)

15143 DECELERATION OF RELATIVISTIC PARTICLES IN LOWER LAYERS OF THE ATMOSPHERE. Krasovitskii, V. B.; Kurilko, V. I. pp 205-8 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

The deceleration of charged relativistic particles in the atmosphere is investigated. The deceleration in the medium is due to energy loss by radiation which is computed on the assumption of a specific model of the atmosphere (isotropic dielectric with a certain dispersion). Three spectral regions are investigated. It is shown that for low particle energy the bremsstrahlung increases as the four-thirds power of energy. At moderate energies (conditions), the maximum radiation occurs at a frequency proportional to the reciprocal of energy and the power loss of a particle is inversely proportional to the square of its energy. As the energy of the particle increases further a more complicated dependence on the energy is found to occur. Also, the spectral peak dependence is different than at lower energies. The Cherenkov radiation for the case considered is always greater than bremsstrahlung when it is necessary to consider the effect of the medium on particle energy. (ATD)

15144 EXCITATION OF WAVES IN BOUNDED PLASMA BY MODULATED BEAMS. Kondratenko, A. N. pp 209-15 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

The effect of a modulated beam injected into a bounded plasma is considered. A slab of plasma bounded by two parallel conducting plates and in a constant magnetic field is assumed to carry sufficiently strong current (in the direction of the magnetic field) so that transverse motion of particles across field lines can be neglected. The excitation of waves by the current flow is considered in the linear approximation and in the weakly nonlinear, but hydrodynamic approximation. The electric field intensity of the wave is derived from the equations which describe the excitation of the wave. The dispersion relation for the nonlinear case is also derived, containing both collisions and Cherenkov absorption of the waves by particles in the plasma. The derivation of phase velocity for high- and low-frequency oscillations indicates that in some regimes the wave electric field has the same form for both types of oscillations. (ATD)

15145 NONLINEAR EFFECTS IN PLASMA WAVEGUIDE (ION CYCLOTRON RESONANCE AT DIFFERENCE FREQUENCY). Ivanov, B. I. pp 178-85 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

The processes responsible for excitation of low-frequency oscillations near the ion cyclotron frequency of the plasma were investigated. A low-power generator was used for excitation of waves in the plasma. In order to study nonlinear processes, low-frequency waves (1 Mc) with slow phase velocities (100 slower than velocity of light) were used in plasma with 10^9 cm^{-3} density. The weak ion cyclotron resonance signal was detected by a special sensitive high-frequency bridge. The wave behavior in the plasma was studied changing the plasma density and the amplitude of the external magnetic field. It was observed that when the generator operated on two frequencies the amplitude of the excited difference frequency increased as the resonance was approached. An increase in magnetic field resulted in increasing resonance frequency. The dispersion of the wave is in agreement with ion cyclotron wave dispersion, but experimentally observed frequency dependence on plasma density was stronger than expected. The measuring techniques and procedures are described in detail. (ATD)

15146 ELECTRON RADIATION IN A PLASMA-MAGNETIC FIELD BOUNDARY LAYER. Dolgopolov, V. V.; Pakhomov, V. I.; Stepanov, K. N. pp 186-9 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

The energy radiated by electrons in the region of a plasma near the plasma–magnetic field is calculated. The calculation is made for a low-density plasma contained by a strong magnetic field such as in a thermonuclear reactor. The computation includes the effect of the anomalous skin thickness which differs from the case of dense plasma. When cyclotron radiation wavelength corresponds to stabilizing oscillation of the plasma and Doppler broadening (of the order of cyclotron frequency) is included, the intensity of the cyclotron radiation emitted by the plasma is given by the equation $I \sim I(\omega)\omega_B \sim (\omega_B^2 \nu_e T/4\pi^2 c^2) \sim (e^3 n_0^{1/2} T^2/c^2 m^{1/2})$. When the plasma polarization is accounted for, the intensity of cyclotron radiation decreases by a ratio of electron rest mass energy to plasma temperature. It is also shown that cyclotron radiation is smaller (by the same ratio) than the bremsstrahlung radiation. These relations hold provided no generation of plasma waves occurs. (ATD)

15147 RADIATION OF LOW-FREQUENCY WAVES BY IONS AND ELECTRONS OF A NONISOTHERMAL MAGNETOACTIVE PLASMA. Pakhomov, V. I. pp 189-205 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

The intensities of Alfven waves and fast and slow magnetoacoustic waves radiated by ions and electrons is calculated. The analysis is carried out in detail for several cases. It is shown that in low-pressure plasma, where the Alfven velocity v_A greatly exceeds the velocity of sound v_s, the index of refraction of the slow wave is much greater than that of the other two waves. This leads to a

great increase in the radiated intensity of the slow wave harmonics of $(v_A/v_s)^{2s+1}$, where s is the harmonic index. It is also proven that Cherenkov radiation of low-frequency waves by the electrons of nonisothermal plasma is a considerable fraction of the total radiation. The radiation and absorption efficiency of plasma for the spectral range of frequencies below ion cyclotron frequency is also computed. Spatial properties of the propagation characteristics are given. (ATD)

15148 DIELECTRIC PERMITTIVITY OF PLASMA IN LINEAR CORRUGATED AND LINEAR HELICAL MAGNETIC FIELDS. Aleksin, V. F.; Yashin, V. I. pp 60-70 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

Permittivity and electrical conductivity tensors of plasmas with helical and corrugated magnetic fields are investigated in connection with the problem of plasma instabilities that have been found to appear in weakly inhomogeneous plasma. These tensors are derived with the aid of the Shafranov method which requires the calculation of particle trajectories in the absence of the equilibrium electric fields. The trajectories are found for the vortex-free corrugated linear fields of cylindrical symmetry for plasma with negligible particle pressures, without axial currents. This is combined with the distribution functions (Maxwellian distribution in equilibrium) and space-dependent conductivity and permittivity terms are derived. Similar computation is made for the helical fields in plasmas with strong magnetic fields. An additional polarization tensor for the plasma is also derived. In both cases, the results are considerably simplified if the wavelength of oscillations is much greater than the maximum and minimum radii of the magnetic surfaces. (ATD)

15149 KINETIC THEORY OF ELECTROMAGNETIC WAVES IN FINITE PLASMA. Kondratenko, A. N. pp 71-83 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

The propagation of electromagnetic waves in an infinite plasma layer is investigated with the aid of the kinetic theory of plasma. A self-consistent system of Maxwell and linearized Vlasov equations for the distribution function departing from the equilibrium conditions is used with a set of boundary conditions appropriate to the infinite layer. Standard methods are used to derive the dispersion relations and the linearized solutions of the distribution function. These in turn lead to Fourier expansions for currents induced by the incident wave. The currents are then used with Maxwell equations to derive integro-differential equations for the electric and magnetic fields and their coefficients are calculated. When the high velocity is taken to be infinite, the derived dispersion relationship is greatly simplified and it is shown that in the long-wavelength limit, both ions and electrons contribute to the wave damping. The ion–acoustic wave dispersion formula is derived giving the damping constant which for surface waves indicates a large contribution by ions to wave damping similar to the effect of electrons in the high-frequency case. As the layer thickness decreases, the phase decreases, increasing and decreasing the contributions to the damping of ions and electrons, respectively. (ATD)

15150 KINETIC THEORY OF SURFACE WAVES IN A PLASMA WAVEGUIDE. Gorbatenko, M. F.; Kruilko, V. I. pp 83-8 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

The damping coefficient of the surface wave on a plane unbounded surface is proportional to thermal velocity for small thermal velocities of plasma electrons. This effect is investigated in the case of a plasma waveguide formed by a layer of plasma of finite thickness. The starting point is the Vlasov and Maxwell equations for the high-frequency part of the distribution function (with the equilibrium part given by a Maxwellian distribution). The form of the solution is a product of the space function with the time and space harmonic parts. A general solution for the distribution function is obtained and used to derive integro-differential equations for the electric field components. This is solved approximately for the case of small thermal velocities. It is shown that in this problem, the damping coefficient of the wave is also proportional to the electron thermal velocity. However, as the plasma layer thickness decreases the phase velocity of the wave decreases. (ATD)

15151 CHARACTERISTICS OF THE ELECTROMAGNETIC FIELD IN A NONHOMOGENEOUS MAGNETOACTIVE PLASMA. Dolgopolov, V. V. pp 89-98 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

The behavior of an electric field of a growing wave in a magnetoactive plasma is studied. With the aid of a permittivity tensor for an arbitrary angle between the direction of the wave and the magnetic field in the plasma, the electric field of the wave is computed using Maxwell equations. The solution is obtained assuming a harmonic form and expanding the resulting fields. In the extreme case of very long waves, the properties of growing waves are found to be the same as those in the isotropic plasma. The rate of the field growth is computed for some special cases. As in inhomogeneous plasma, the intensity of thermal radiation from the transparent plasma is comparable to blackbody intensity. This fact gives the inverse relation (for the radiation absorption) for waves with wavelengths comparable to the distance between the plasma boundary and the point in the plasma when the largest growth occurs. This relation holds that no significant heating can occur in the case of laboratory plasmas when waves with microwave frequencies are used. (ATD)

15152 EXCITATION OF A MAGNETOHYDRODYNAMIC WAVEGUIDE BY A COAXIAL WAVEGUIDE. Kalmykova, S. S.; Kurilko, V. I. pp 98-100 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

The generation of an axially symmetric E wave in an MHD waveguide by a coaxial waveguide is discussed. Plasma temperature is neglected, allowing the use of a tensor for the dielectric without spatial dispersion. Electric and magnetic field equations are derived and a reflection coefficient at the boundary adjoining the two waveguides is derived for the case of a dense plasma. It is pointed out that in computing the amplitude of the waves in the MHD waveguide, four different regimes are observed. For each one of these, the amplitude of the magnetic field is derived. These results show that the waves can be excited effectively by a coaxial waveguide only in the presence of sufficiently strong magnetic fields. In the case of low fields, only surface waves are excited. In intermediate cases, some high harmonics are weakly excited. (ATD)

15153 THEORY OF THE PROPAGATION OF MAGNETOHYDRODYNAMIC WAVES AT THE END OF A WAVEGUIDE. Kurilko, V. I. pp 100-9 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

A semi-infinite plasma waveguide is studied in order to illuminate the propagation of the waves near the ends of experimental waveguides filled with plasma. The derivation of the field equations is shown to lead to two coupled integral equations, which for the case considered, are reduced to a coupled system of an infinite number of algebraic equations. The plasma waveguide considered for this problem is assumed to have infinite conductivity and zero temperature. In the presence of a small parameter arising from the small diameter of the waveguide (relative to wavelength), the Fourier components can be obtained analytically. This allows derivation of the behavior of the waves at the end; their transformation and reflection coefficients are obtained. It is seen that the coefficients of mutual transformation of high harmonics decrease with the increase in the work number and with a decreasing magnetic field. (ATD)

15154 EXCHANGE OF ENERGY BETWEEN HIGH- AND LOW-FREQUENCY OSCILLATIONS IN PLASMA. Fedorchenko, V. D.; Muratov, V. I.; Rutkevich, B. N. pp 118-26 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

Interaction between high and low frequencies of plasma oscillations was investigated experimentally and theoretically. A simple model is assumed to provide the relationship between these two frequencies and the intensity of the magnetic field. The theoretical results were tested experimentally using an electron beam (20 to 40 ma) moving through a gas at pressures in the 10^{-6} mm Hg range. The interaction of the waves was studied under the condition where the external excitation field: (1) did not coincide with either electron plasma or electron cyclotron frequency; (2) coincided with electron plasma frequency; and (3) coincided with electron cyclotron frequency. The intensities of the excited blue- and red-shifted satellites were found to be different, indicating coupling to low frequencies, and their relative intensity increased with the increase of excitation signal intensity. The increase of the external magnetic field intensity increased the coupling of the external signal to the ion oscillations. The experiments show that electron oscillations transfer their energy into the ion component of the plasma, leading to net plasma heating. (ATD)

15155 DAMPING OF INITIAL EXCITATIONS AND STOP OF GROWTH OF FLUCTUATIONS IN A COLLISION-FREE PLASMA. Akhiezer, A. I.; Akhiezer, I. A.; Polovin, R. V. pp 133-9 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

The mechanism of the stopping of the growth of initial fluctuations of macroscopic quantities in nonequilibrium plasma is investigated for the case of an unbounded plasma. Following Landau's

theory a general Fourier component time development is obtained. The undisturbed equilibrium distribution functions which can be analytically continued into complex domains are chosen for this study. Two examples, where frequencies and damping coefficients are given by the initial excitation and do not depend on plasma property are closely examined. It is shown that Dirac δ singularities lead to undamped excitations, in contradistinction to Landau's results. This result is generalized to singularities in higher derivatives and the asymptotic form of the potential components is derived. The behavior of the fluctuations is similar to that given by Rostoker and provides an estimate of time when the growth of fluctuations in nonequilibrium plasmas stops. (ATD)

15156 INTERACTION OF CHARGED PARTICLES WITH A TURBULENT PLASMA. Akhiezer, I. A. pp 139-42 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

Energy loss (or gain) per unit time by a charged particle moving through a turbulent plasma is calculated from a general expression which depends on the charge density correlator. This correlator is written out explicitly for the "sonic" region of the plasma which has a much higher electron than ion temperature. It is shown that under these conditions, the plasma temperature gradients, rather than temperature, determine the energy losses. The substantial contribution to the loss is limited to the region around resonance, so that a small number of parameters is needed to specify the loss per unit time. This result also implies that turbulence spectrum peculiarities do not have a strong effect on the resulting losses. In addition, the rate of change of particle energy is derived in an analytic form, giving the dependence on particle velocity and direction. (ATD)

15157 THEORY OF THE NONLINEAR MOTION OF A NONEQUILIBRIUM PLASMA. Akhiezer, I. A. pp 142-8 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

The kinetic equation for a nonequilibrium plasma is used to study wave dispersion in the collisionless regime. The equation is rewritten using distribution function moments; small charge separation in the sound waves considered here is assumed. This system of equations is used to follow the evolution of finite amplitude waves characterized by the density, phase velocity, and distribution moments. The initial Maxwell distribution is studied in greater detail, where sound velocity and distribution momenta per unit density are density-independent, allowing use of isothermal hydrodynamics. In a two-temperature plasma which has a compressing boundary, a self-similar wave exists in the absence of any shock processes. This allows one to write a set of equations which connect all quantities characterizing the plasma behavior in terms of the compressing velocity which is analogous to piston velocity in the hydrodynamic case. (ATD)

15158 NONLINEAR PROCESSES IN ONE-DIMENSIONAL AND ONE-COMPONENT PLASMA. Khizhnyak, N. A.; Korsunskii, A. M. pp 148-55 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

More general nonlinear solutions of the one-dimensional kinetic equation without collisional term are studied. It is assumed that the distribution function depends explicitly on velocity and the self-consistent electric potential. It is shown that such systems can be described in the framework of a hydrodynamic approximation and the electron distribution function's dependence on velocity can be given. The general results are applied to the problem of wave propagation in media with linear and quadratic dispersion laws. The solutions permit one to construct dispersion functions which in the latter case go to Maxwellian form in the limit of vanishing field. There also exists a group of electrons with a velocity range such that they do not contribute to the distribution function. The results of this work allow the history of electron groups to be traced in their collisionless transition from the trapped range and in heating of their plasma electrons. (ATD)

15159 INDUCED DISPERSION OF LANGMUIR OSCILLATIONS OF A PLASMA IN STRONG MAGNETIC FIELD. Shapiro, V. D.; Shevchenko, V. I. pp 156-64 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

Nonlinear interaction of wave harmonics in the long wavelength range of the spectrum is investigated for the conditions of a strongly magnetized plasma. The linear damping of the waves is considered small due to the small number of resonance particles and all oscillations are along the field lines. The mathematical description of the system employs a set of equations for the electron and ion distribution functions and for the electric field. The system is analyzed in the second and third approximation starting with linear solutions. The initial one-dimensional spectrum remains nearly uniform under the action of dispersive effects and is seen to correspond within a cosine factor to the one-dimensional model. The interaction between waves leads to pumping of energy from the higher frequency part of the spectrum to the lower. The dissipation of wave energy by plasma particles is considerably smaller than loss of energy to lower frequency waves. (ATD)

15160 CHARGE SEPARATION EFFECTS IN THE FERRARO–ROSENBLUTH COLD PLASMA SHEATH MODEL. Davies, Christine M. (London Univ.). Phys. Fluids, 10: 391-5(Feb. 1967).

The exact relativistic treatment is given of the Ferraro–Rosenbluth cold plasma sheath model, and is compared with the nonrelativistic solution given previously by Sestero. It is found that the anamolous solution obtained by Sestero, namely, the fact that the ions turn back before the electrons, persists in the relativistic treatment although the ion stream and electron stream are separated in space. As in the Sestero solution it is found that the overall charge in the sheath is not, in general, zero. Numerical illustrations are given for the case when the velocities are comparable with the velocities encountered in the solar wind. (auth)

15161 CONVECTIVE INSTABILITIES DRIVEN BY ELECTROMAGNETIC WAVES. Lindman, E. L. (Univ. of Texas, Austin). Phys. Fluids, 10: 396-405(Feb. 1967).

A description of destabilizing effects present in a plasma due to the rf motion of the two species is obtained by expanding the fluid equations and the electromagnetic wave equations in an asymptotic series in $1/\omega_{rf}$. Equations for the high-frequency and low-frequency motion are separated, linearized, and solved for a plasma with a density gradient perpendicular to a magnetic field. An electromagnetic wave propagating in a direction parallel to the density gradient at a frequency near the lower hybrid is considered. A convenient method of description of the interaction between the electromagnetic wave and the unstable density perturbation involving the simultaneous introduction of more than one phase operator (i) is given. It is found that time average $v_{rf} \cdot \nabla v_{rf}$ terms which contain the effects of rf gradient forces lead to instability in qualitative agreement with experiments on electrodeless rf discharges. (auth)

15162 LINEARIZED SUPERPOSITION THEORY OF A CLASSICAL ONE-COMPONENT PLASMA. Levitt, Leo C. (Georgetown Univ., Washington, D. C.); Richardson, John M.; Cohen, E. Richard. Phys. Fluids, 10: 406-13(Feb. 1967).

The equilibrium theory of a one-component nondegenerate charged gas, in a uniform continuum of a neutralizing charge, is studied on the basis of a linear-closure procedure for the BBGKY hierarchy which, in the present instance, corresponds to the use of the linearized Kirkwood superposition approximation, and leads to a second-order linear differential equation for the radial distribution function. Its solution is studied, numerically and analytically, for a wide range of the plasma parameter, $\gamma = e^2/kTA_D$, where Λ_D is the Debye length. Results for $\gamma \ll 1$ are compared with corrections to the Debye–Hückel theory derived by Abe and others. Solutions for $\gamma \gg 1$, which approach an ordered state of the system as γ increases, are compared with two simple "model" calculations of the equilibrium theory of a body-centered cubic lattice of charges in a uniform background of compensating charge. The thermodynamic properties of these "Coulomb lattice" models are in qualitative agreement with those of the plasma as computed via the closure approximation for $\gamma \gg 1$. The possibility is therefore suggested that, even for large γ, the linear closure approximation has a larger degree of validity than might be expected a priori. (auth)

15163 HIGH-SPEED PLASMA FLOW IN A CUSPED MAGNETIC FIELD. Tanaka, Masatoshi (Japan Atomic Energy Research Inst., Tokyo). Kakuyugo-Kenkyu, 18: No. 1, 1-11 (Dec. 1966). (In Japanese).

High-speed plasma flow in a cusped geometry is investigated in the free-particle approximation. The density distribution of the plasma in a plane perpendicular to the axis of the field, say $z = z_0$, is known and plasma ions there have a Maxwellian distribution of velocities. The ion density in the downstream flow was investigated. The collision-free Boltzmann equation is solved successively by assuming that the flow velocity is much larger than the mean thermal velocity of the ions. When the radial density distribution at $z = z_0$ is gaussian, the downstream density distribution is also gaussian. (NSA of Japan)

15164 TRANSPORT COEFFICIENTS OF PARTIALLY IONIZED ARGON. Devoto, R. S. (Stanford Univ., Calif.). Phys. Fluids, 10: 354-64(Feb. 1967).

The complete Chapman–Enskog–Burnett expressions for the transport coefficients of multicomponent gas mixture are applied to the computation of the properties of partially ionized argon. Studies of the rate of convergence of the approximations to the coefficients show that the third approximation to the thermal con-

ductivity and the second to the viscosity are adequate at all degrees of ionization. The ordinary ambipolar diffusion coefficient is given to excellent accuracy by twice the binary ion–atom diffusion coefficient but, at low ionization, apparently not even the fourth approximation to the electrical conductivity has converged to the true value. The computed electrical and thermal conductivities are compared with experimental measurements. (auth)

15165 TRANSPORT PROPERTIES OF A NONEQUILIBRIUM PARTIALLY IONIZED GAS. Chmieleski, Robert M.; Ferziger, Joel H. (Stanford Univ., Calif.). Phys. Fluids, 10: 364-71 (Feb. 1967).

A modified Chapman–Enskog approach for an ionized gas is presented. The method allows the electron and heavy particle temperatures to differ while requiring all species to have the same macroscopic velocity to zero order. Expressions are obtained for the transport properties of such a gas and a complete set of self-contained hydrodynamic equations is given. As an example, the transport properties of a fully ionized gas containing a single ion species are evaluated using the cutoff Coulomb potential. In the limit of equal electron and ion temperatures, the results are in agreement with previous results. (auth)

15166 SUMMATION OF SERIES FOR CYCLOTRON HARMONIC WAVE DISPERSION. Diament, Paul (Stanford Univ., Calif.). Phys. Fluids, 10: 470-2(Feb. 1967).

The slowly convergent series previously quoted for cyclotron harmonic wave dispersion relations are converted into more rapidly convergent forms, convenient for numerical and analytic work. (auth)

15167 THERMAL CONDUCTIVITIES OF PLASMAS IN GENERAL FORCE FIELDS. Meador, W. E. (Langley Research Center, Hampton, Va.). Phys. Fluids, 10: 467-9(Feb. 1967).

It is shown that the Meador–Staton results for the reaction conductivity are valid, in the case of ambipolar diffusion, for general electromagnetic fields and nonuniform total pressure. Comparisons are made with the method of Ahtye. (auth)

15168 LARGE AMPLITUDE WHISTLER WAVES IN A HOT COLLISION-FREE PLASMA. Sonnerup, B. U. O.; Su, Shin-yi (Dartmouth Coll., Hanover, N. H.). Phys. Fluids, 10: 462-4 (Feb. 1967).

A dispersion relation is derived for large-amplitude circularly polarized plane waves propagating along a uniform magnetic field in a hot collision-free plasma. (auth)

15169 HOT PLASMA IN A CYLINDRICAL WAVEGUIDE. Swanson, D. Gary (Univ. of Texas, Austin). Phys. Fluids, 10: 428-35(Feb. 1967).

An approximate theory for the propagation of waves in a hot plasma in a cylindrical waveguide with an arbitrary axial magnetic field is presented. The boundary value problem is treated by a perturbation expansion in the smallness of the Larmor radius compared to the transverse wavelength. In the limit of zero Larmor radius, only the electromagnetic boundary conditions are important, while acoustic and higher-order boundary conditions appear as corrections. The results to zero order in Larmor radius are found to be formally identical to the cold plasma equations. Mode orthogonality and some limiting cases are also discussed. (auth)

15170 INTERACTION OF AN ELECTRON BEAM WITH A COLLISIONLESS PLASMA. Carnevale, M.; Crosignani, B.; Engelmann, F. (EURATOM-CNEN, Frascati, Italy). Phys. Fluids, 10: 436-40(Feb. 1967).

The growth of electrostatic wave excitation in a collisionless plasma, interacting with an electron beam of finite length, as well as the simultaneous modification of the beam are studied for weakly unstable situations. Using quasi-linear theory, explicit results as a function of space, of time, and of the plasma and beam parameters are obtained for the surface layer where the relaxation of the beam effectively takes place. The effect on the beam of both unstable modes and resonant stable modes of thermal excitation is considered. (auth)

15171 WAVE PROPAGATION IN A RAREFIED ROTATING PLASMA WITH FINITE LARMOR RADIUS. Bajaj, N. K.; Tandon, J. N. Mon. Notic. Roy. Astron. Soc., 135: 41-50(Jan. 1967).

The effect of the finite ion Larmor radius on wave propagation in a rarefied rotating magnetized plasma (rotation vector being parallel to the magnetic field vector) has been investigated and, for the purpose of illustration, the results have been applied to solar corona. It is shown that finite ion Larmor radius and rotation have self-cancelling effects on Alfvén waves propagated along the magnetic field, the self-cancellation being complete for waves with wavelength approximately one-hundredth the solar radius. Transverse to the magnetic field ion-sound mode with wavelength less than about 2×10^{-4} R_0 (R_0 being the solar radius) is influenced by finite ion Larmor radius and that with wavelength larger than 0.2 R_0 is affected by rotation. (auth)

15172 STABILITY OF MANY-PARTICLE SYSTEMS WITH EXTERNAL PERTURBATIONS. I. DERIVATION OF MOMENTUM EQUATIONS. Lenk, Richard (Technische Hochschule, Karl-Marx-Stadt, Ger.). Z. Naturforsch., 21a: 1556-61(Oct. 1966). (In German).

As a consequence of the second law of thermodynamics the imaginary parts of linear response functions are positive definite for positive frequencies. Resulting from this fact inequalities based on the fluctuation dissipation theorem are derived for the moments of these imaginary parts and of the related correlation functions. Moments without physical meaning have been eliminated. (auth)

15173 STABILITY OF MANY-PARTICLE SYSTEMS WITH EXTERNAL PERTURBATIONS. II. PERTURBATION BY POTENTIAL FIELDS. Lenk, Richard (Technische Hochschule, Karl-Marx-Stadt, Ger.). Z. Naturforsch., 21a: 1562-76(Oct. 1966). (In German).

Inequalities derived in Part I are investigated for extended one-component systems perturbed by longitudinal fields. A new sum rule first derived by Puff plays a central role. For interactions with finite range the frequencies of elementary excitations related to density oscillations must go to zero with the wave number. There are two lower bounds for density fluctuations, one for thermal and the other for quantum fluctuations. In a plasma with homogeneous background the long range of the interactions suppresses fluctuations of particle number. The new sum rule is modified in such a way that plasma oscillations (with finite frequency for zero wave number) become possible in accordance with the stability conditions. Lower bounds for the range of pair correlations in a plasma are derived. They give the exact ranges for the classical and the ground-state plasma. For low temperatures and densities the pair distribution function must show strong oscillations. (auth)

15174 ENHANCEMENT OF INTENSITIES OF THE ION PLASMA OSCILLATION DUE TO BUNCHED ELECTRONS. Yoseli, Morihiro (Electrotechnical Lab., Tokyo). J. Phys. Soc. Jap., 22: 353-4(Jan. 1967).

The enhancement of intensities of the ion plasma oscillation due to bunched electrons in the hot cathode discharge in mercury vapor is described. The discharge tube had an oxide-coated flat cathode of 5 mm in diameter, an anode, which was 20 mm in diameter and had a hole of 3 mm in diameter in the center, located at 10 mm apart from the cathode face, and a disk of 20 mm in diameter located in the other side to the cathode at 5 mm from the anode. (M.O.W.)

15175 ANOMALOUS BREMSSTRAHLUNG IN PARTIALLY IONIZED PLASMAS. Tanaka, Shigetoshi; Takayama, Kazuo (Univ. of Nagoya, Japan). J. Phys. Soc. Jap., 22: 300-6(Jan. 1967).

The anomalous bremsstrahlung from partially ionized plasmas is observed in the absence as well as in the presence of the magnetic field when the detecting frequency f is smaller than a critical frequency f_{crit}, which is somewhat smaller than the collision frequency of plasma electrons; on the other hand, the anomalous cyclotron emission described previously appears when f exceeds f_{crit}. The experimentally observed characteristics of the former emission are very similar to those of the latter, except for their dependence on the magnetic field and their frequency ranges. The theoretical considerations suggest that the effect of negative absorption due to the stimulated bremsstrahlung may occur in plasmas. It is shown that one can interpret the anomalous bremsstrahlung as a phenomenon resulting from this effect. (auth)

15176 AMPLIFICATION OF RADIO-WAVES IN PARTIALLY IONIZED GASES. Tanaka, Shigetoshi; Takayama, Kazuo (Univ. of Nagoya, Japan). J. Phys. Soc. Jap., 22: 310-18(Jan. 1967).

The amplification of radio-frequency waves is observed in partially ionized gases, having large Ramsauer effect, in the absence of magnetic field. Results showing power gains of more than 4 db at 60 Mc and 3 db at 20 Mc in a xenon discharge plasma are presented. By adjusting a dc grid current of a triode-type discharge tube, a strong attenuation or an amplification of an applied rf wave or an intense rf emission with no input signal is observed. This phenomenon occurs in pulses at some definite phase of a lf oscillation existing in the dc discharge when the detecting frequency is smaller than the critical one, which is somewhat smaller than the collision frequency of the plasma electrons. It is considered that experimental results are interpreted as a phenomenon of the negative absorption due to the stimulated bremsstrahlung in partially ionized gases. (auth)

15177 NON-LINEAR PHENOMENA IN BEAM-PLASMA INTERACTION. Yamamoto, Takayoshi; Ohniwa, Kohji; Akimune,

Hideo; Suita, Tokuo (Osaka Univ.). J. Phys. Soc. Jap., 22: 277-84(Jan. 1967).

A modulated weak electron beam is injected into a low-density diffused plasma and growth rates of convective instabilities are observed. The growth rates obtained experimentally are in pretty good agreement with those calculated from the dispersion relation including only the collisional damping effect if the beam density is relatively low. However, if the beam density is high, the experimental results conspicuously deviate from the calculated values. These results suggest that it becomes difficult for the amplified wave to maintain its coherence as the amplitude increases, and that such a nonlinear effect would cause breakdown of the amplified waves. The ratio I_1/I_0 is adopted as a measure of the threshold over which the nonlinear effect becomes remarkable, where I_0 and I_1 are the zero-order and first-order electron currents in the beam-plasma system respectively. As I_1/I_0 approaches unity breaking of the wave becomes observable. (auth)

15178 XENON PLASMA FROM FOCUSED COAXIAL GUN. Dunne, Brian; Benham, Benson P. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Rev. Sci. Instrum., 38: 10-16(Jan. 1967).

A technique has been developed for focusing a plasma beam from a coaxial accelerator which increases the plasma energy per unit area by a factor of fifteen or more without reducing the front velocity. The pressure, impulse, and power flux characteristics of a xenon plasma were measured outside the focusing device of the accelerator to optimize the operational parameters. The plasma pulse has a 10^7 cm/sec front velocity, and sufficient cross sectional area, density, duration, and uniformity to be useful in plasma-solid interaction studies at high power fluxes (~45 to 100 MW/cm^2), where radiation is the dominant mode of energy transfer. (auth)

15179 PROPERTIES OF THE DISPERSION KERNEL OF A HOMOGENEOUS HOT PLASMA WITHOUT MAGNETIC FIELD. Rolland, Paul (Centre d'Etudes Nucleaires, Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. B, 263: 1376-9(Dec. 19, 1966). (In French).

Landau has shown the effect of poles of a certain function $D^{-1}(\omega,k)$ on the wave form in a plasma. This same function appears in numerous problems (scattering, fluctuations, non-collisional effects). Some authors have recently shown that this function can present an infinity of poles. Some results are indicated which make it possible to find in a general fashion the singularities of D^{-1} by the simple examination of the analytical properties of the f_0 distribution. (tr-auth)

15180 DAMPING AND INSTABILITIES OF CYCLOTRON WAVES IN A PLASMA. Scharer, John Edward. Berkeley, Calif., Univ., of California, 1966. 103p.

Thesis.

The propagation of a transverse electromagnetic wave along the direction of a uniform magnetic field in an unbounded, anisotropic thermal plasma is investigated. Linearized Vlasov equations are used to obtain the dispersion relations for electron and ion cyclotron waves to determine the conditions under which efficient transfer of energy from an electromagnetic wave to a magnetically confined plasma takes place. The growth and damping of the cyclotron waves due to the thermal anisotropy is then studied. Plasma electromagnetic instabilities arising from "loss cones," such as those found in a magnetic mirror, are investigated, and the enhancement of mirror end losses due to the instability is discussed. For the electron cyclotron wave, the threshold of instability equation is derived, and it is found that for $T_{\perp e} > T_{\parallel e}$ there is a critical frequency and wave number below which the wave is unstable and above which the wave is damped. The marginally stable frequency is found to depend only on the electron cyclotron frequency and the thermal anisotropy of the electrons. The growth and damping rates are obtained numerically for several cases and it is found that the maximum growth rates occur just below the marginally stable frequency. The maximum damping rates occur when the wave approaches cyclotron resonance. The thermal anisotropy of the ions and electrons is included in the analysis of the propagation of ion cyclotron waves. When the ion cyclotron wavelength is much greater than the longitudinal distance a thermal electron moves in an electron cyclotron period, it is found that the electrons have a destabilizing effect on the wave for $T_{\perp e} > T_{\parallel e}$ and a stabilizing effect on the wave for $T_{\parallel e} > T_{\perp e}$. The relative influence of the ions and the electrons on the damping and instability of the ion cyclotron wave is discussed. Plasma electromagnetic instabilities in a magnetic mirror machine are considered by introducing an anisotropic Maxwellian velocity distribution with loss cones. A numerical solution of the dispersion relation is obtained and it is found that an initially isotropic distribution with loss cones is unstable for sufficiently long wavelength. This instability resulting from the loss cones is shown to be equivalent to that driven by thermal anisotropy. The enhancement of mirror end losses due to the diffusion of particles in velocity space due to the instability is discussed. (Dissertation Abstr.)

Production of Plasma

15181 (CEA-R-3109) SOURCES PULSEES INTENSES D'IONS ET D'ELECTRONS PRODUITES PAR LASER. (Intense Pulsed Sources of Ions and Electrons Produced by Lasers). Bourrabier, Guy; Consoli, Terenzio; Slama, Lucien (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov. 1966. 21p. (In French). Dep. mn.

A device is described for the acceleration of plasma bursts produced by focusing a laser beam into a metal target. The electrons and ions are extracted from the plasma. The maximum current is around 2000 amperes for a few microseconds. The study of the effect of the kind of target on characteristics of the current shows the great importance of initial conditions, i.e., the ionization potential of the target and the laser energy. (auth)

15182 (NYO-3578-5) PRODUCTION OF PLASMAS FOR THERMONUCLEAR RESEARCH BY LASER BEAM IRRADIATION OF SOLID PARTICLES. Semiannual Report, June 29, 1966-December 31, 1966. Haught, Alan F.; Polk, Donald H. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Jan. 31, 1967. Contract AT(30-1)-2578. 31p. (UARL-E-920365-5). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An experimental and theoretical investigation was made of the production of plasmas for thermonuclear research by laser beam irradiation of a small solid particle. For these studies the focused high intensity beam from a Q-spoiled laser is used to form a high-temperature, high-density plasma from a single solid particle of lithium hydride 10 to 20 μ in diameter which is electrically suspended in a vacuum environment free of all material supports. Both detailed hydrodynamic calculations and a simplified integrated similarity model of the plasma generation and growth have been developed. These models, which include the effects of laser pulse time history, fraction of the incident beam absorbed by the expanding plasma, and radial density and velocity gradients within the plasma, give results for the plasma radial density distribution, velocity profile, and plasma energy in good agreement with those determined experimentally. Calculations of the plasma energy as a function of particle size, R_0, focal spot radius, Γ, laser power, and laser pulse duration have been carried out spanning the R_0, Γ plane. The highest plasma energies can be obtained over a range of R_0, Γ values, and this maximum plasma energy increases with decreasing laser pulse duration. Measurements have been carried out to examine the interaction of these laser produced plasmas with mirror, cusp, and minimum-B fields. In a mirror magnetic field, the spherically symmetric expansion of the field-free experiments is substantially altered. For directions transverse to the magnetic field both a reduced charge collection and a longer collection time indicate that the plasma is not freely expanding but is to some extent confined by the magnetic field. The measured axial plasma flux is proportional to the square of the magnetic field strength, in agreement with a simple model of the effects of plasma containment on the ion charge collected by a collector of small but fixed aperture. In a cusp magnetic field, a reduced plasma flux across the magnetic field and an increased charge collection time are again indicative of magnetic field containment, and the B^2 dependence of the measured axial plasma flux is in accord with the simple containment picture. In the plane of the ring cusp, the plasma loss is unaffected by the presence of the magnetic field. With a minimum-B magnetic field, produced by one pair of mirror coils and two orthogonal sets of cusp coils, results similar to those of the magnetic mirror are obtained. At a given field strength, however, the minimum-B field shows substantially increased containment and is as effective as a mirror field 1.5 times as great. (TSS)

15183 (RFP-792) CURRENT DISTRIBUTION TO A PLANE SHIELDED CATHODE IN THE ABNORMAL GLOW DISCHARGE. Mullaly, J. R. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Feb. 10, 1967. Contract AT(29-1)-1106. 24p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The distribution of current over the surface of a plane shielded cathode in the abnormal glow discharge was determined for different values of voltage, pressure, anode-cathode spacing, and magnetic field. All work was done with argon at pressures of 30 microns or lower in a 12-inch diameter Pyrex glass bell jar. Metal removal is compared with current distribution. Two appendices are given; one briefly reviews abnormal glow discharge and the other gives total discharge current increase as a function of magnetic field strength. (auth)

15184 (RISO-M-504) A REVIEW OF SHOCK WAVE THEORIES (GASDYNAMIC SHOCKS). Chang, C. T. (Danish Atomic

Energy Commission, Risoe. Research Establishment). Feb. 1967. 55p. Dep. mn.

Discussions are presented on the following: (1) fundamental aspects of a compressible flow (examples of the occurrence of shock waves), (2) the formation of a shock wave, (3) general description of a gasdynamic shock, and (4) the structure of a gasdynamic shock. (M.O.W.)

15185 (SC-CR-66-2145) STUDIES OF IONIZING SHOCK-WAVES IN HYDROGEN. Progress Report No. 73. Freeman, J. R.; Byatt, W. J. (New Mexico Univ., Albuquerque. Bureau of Engineering Research). Dec. 1966. Contract AT(29-1)-789. 28p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For Sandia Corp., Albuquerque, N. Mex.

A continuation of previously reported work in the field of ionizing shock waves in the presence of magnetic fields is presented. In particular, an extension of the model to include a description of the inverse pinch experiments described by Vlases is discussed. The similarity between classical blast wave theory and an inverse pinch device, discussed by Vlases, is shown to be in approximate agreement with the computed results. (M.O.W.)

15186 HIGH FREQUENCY DISCHARGE WITHIN A RING ELECTRODE. Andreev, A. D.; Il'in, V. D.; Lobanov, Yu. N. Zh. Tekh. Fiz., 36: 1636-8(Sept. 1966). (In Russian).

An investigation was made of the excitation of nitrogen plasmas within a cylindrical chamber by a high-frequency voltage applied to a cylindrical electrode outside of and coaxial with the chamber. The cylindrical chamber was approximately 78 mm in diameter and 19 mm in length. The plasmas were excited by applying 2 to 6 kV to 2 MHz from an impact excited oscillator to the external cylindrical electrode. The plasmas were photographed through the end wall of the chamber; the radiation emitted by the plasmas was detected with a photomultiplier and its pulsation was observed with an oscilloscope; and the electron density and temperature of the plasmas were measured with the aid of a probe in the center of the chamber. At high nitrogen pressures (1 torr) the visible discharge within the chamber was confined to a thin layer next to the wall. When the pressure was reduced, the discharge broke away from the wall and extended toward the center of the chamber. As the pressure was decreased from 0.06 to 0.02 torr the radius of the region of greatest luminosity decreased from 38 to 24 mm. At low pressures, when the radiation came from regions of the chamber far from the walls, the radiation intensity pulsated at the 2 MHz excitation frequency; at high pressures, when the radiation came only from the immediate vicinity of the wall, it pulsated at twice the excitation frequency. The electron concentration decreased from 4×10^{11} to 2.6×10^{10} cm^{-3} as the gas pressure was reduced from 0.9 to 0.05 torr. The electron temperature remained practically independent of the exciting voltage at about 5 eV. (ATD)

15187 STUDY OF THE CONDITIONS FOR GENERATING A DENSE PLASMA IN A METAL CHAMBER AND THE HIGH-FREQUENCY HEATING OF PLASMA. Shvets, O. M.; Ovchinnikov, S. S.; Tarasenko, V. F.; Brzhechko, L. V.; Pavlichenko, O. S.; Tolok, V. T. pp 26-38 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

The generation of plasma in a metal container and the properties of such a plasma were investigated. A diagram of the experimental apparatus is shown. Up to 100 kW can be generated at frequencies of 1.82×10^6 Hz. The magnetic field which can be produced in several configurations, has a maximum value of 2×10^5 A/m. The plasma diagnostics consist of: 1) voltage monitoring across the plasma column, which determines the coupling between the generator and the plasma load; 2) spectral measurements of plasma ions and impurity lines, giving the density and temperature of the ions; and 3) magnetic probes to determine the field distributions. A plasma density of 2×10^{14} cm^{-3} and a temperature of 4×10^5 °K were attained. Another set of experiments was performed to observe the launching of high-frequency waves into the plasma to produce ion heating. The results of these experiments show that when argon plasma was used, an ion temperature of 2×10^6 °K was reached. Since the ion temperature depends strongly on the applied voltage, it is concluded that higher voltage would result in hotter plasma. It was also shown that a mixture of two different ionic species can be effectively heated; the energy transfer mechanism, however, must be further investigated. (ATD)

15188 ATTENUATION OF A SHOCK WAVE DUE TO THE NONEQUILIBRIUM IONIZATION AND RADIATION. Rosciszewski, Jan (General Dynamics/Convair, San Diego, Calif.). Phys. Fluids, 10: 269-73(Feb. 1967).

The influence of nonequilibrium ionization and radiation on the flow generated by a strong shock wave is discussed. Particularly, the shock wave attenuation is calculated using linearized theory, assuming the degree of ionization to be much less than one. (auth)

15189 ENERGY AND ANGULAR DISTRIBUTIONS OF IONS STRIKING DIFFERENT PORTIONS OF THE CATHODE IN A HIGH VOLTAGE PENNING DISCHARGE. Kurbatov, O. K. Zh. Tekh. Fiz., 36: 1665-8(Sept. 1966). (In Russian).

An investigation was made of the energy and angular distributions of the ions striking the cathode of a 7 kV Penning discharge in air at from 10^{-4} to 10^{-6} torr in an effort to obtain information relevant to the operation of several magnetic discharge pumps. The experimental equipment and results are described. (TSS)

15190 PROPERTIES OF A LABORATORY PLASMA PREPARED WITH COMBINED TRANSVERSE AND LONGITUDINAL CURRENTS. Brown, I. G.; Lehane, J. A.; Potter, I. C.; Watson-Munro, C. N. (Univ. of Sydney). Austral. J. Phys., 20: 47-57 (Feb. 1967).

For some laboratory plasma physics experiments it is necessary to have a plasma of high fractional ionization that is confined in a relatively low magnetic field and for which the charged-particle densities and kinetic temperatures do not change too rapidly in space or time. It has been found that a plasma prepared by a "hybrid" method with ionizing currents, both transverse and parallel to the steady magnetic field, has distinct advantages for such experiments. The hybrid method of preparation is described. Results on the current distribution in the plasma and on the conditions limiting the use of this method are given. The gross behavior of the plasma was studied with an image converter camera; particle densities were determined from Stark spectral observations and from laser interferometry; and electron temperatures were derived from spectral observations and from plasma electrical conductivity. Alfvén waves were used to obtain information on total particle density, fractional ionization, and electron temperature. (auth)

15191 GASODYNAMIC PROCESSES IN GAS HEATED BY LASER RADIATION. Afanasev, Yu. V.; Krol, V. M.; Krokhin, O. N.; Nemchinov, I. V. Prikl. Mat. Mekh., 30: 1022-8(Nov.-Dec. 1966). (In Russian).

A laser radiation flux F_0 incident on the surface of a solid is adsorbed in a metal layer on the order of 10^{-4} to 10^{-5} cm. The internal energy of the absorbing layer $\underline{e}$ becomes much greater than the heat of evaporation. If it is assumed that the absorption coefficient decreases with increasing temperature and increases with increasing gas density, the gas vapor does not shield the surface of the solid. Intense evaporation of material takes place with an increase in gas density. In turn, this process increases the radiation absorption in the vapor, and thus shields the surface. The evaporation rate decreases, and this behavior leads to a decrease in the absorption coefficient. Thus, the process repeats itself, and the optical thickness of the layer of evaporated substance attains a constant value. Equations of motion, continuity, energy and radiation transfer are written in Lagrangian mass coordinates. It is assumed that the absorption coefficient K is a power function of the internal energy $\underline{e}$ and density ρ: $K = a\underline{e}^{\beta}\rho^{\alpha}$. For a fully ionized plasma, for example, $\alpha = 2$ and $\beta = -3/2$. The equation of state for the gas is $e = pv/(x - 1)$, where x is the adiabatic coefficient. Equations are obtained for the maximum temperature of the gas layer, the propagation time of the rarefied wave, and the internal energy of the gas. The numerical results are in agreement with the description given above. (TTT)

15192 GENERATION OF SHOCK WAVES IN AN INVERSE PINCH. Sorrell, Furman Yates Jr. Pasadena, Calif., California Inst. of Tech., 1966. 152p.

Thesis.

A problem inherent in magnetic shock tubes is the difficulty of achieving separation of the driving current sheet and the shock wave. If such devices are to be applied to produce shock waves for experimentation, then separation will usually be a necessary requirement. In an inverse pinch shock tube, preliminary measurements showed that not only was separation not achieved, but under certain conditions the shock was actually found to be located far behind the front of the current sheet. This appeared to be a paradoxical case of the shock wave pushing the piston. Moreover, measurements of the current sheet velocity indicated that the interaction of the current sheet with the gas should be strong enough to sweep up all the gas encountered by the current sheet and thus to produce a shock wave moving ahead of it. In order to find explanations for the absence of separation and for some other puzzling aspects of these early experiments, further measurements were made to study in more detail the processes taking place in the device. These included measurements of the radial electric field with electrostatic probes and of the ionization levels by the technique of spectral line broadening. The results of these measurements show that the degree of ionization is surprisingly low and that the amount of gas leaking through the current sheet is significantly high in some cases. The conclusion is then reached that although the so-called "snowplow model" is

successful in predicting the current sheet velocity, it does not lead to the correct picture of the physical processes taking place. Finally, conditions for which separation may be achievable are inferred from the experiments. (Dissertation Abstr.)

Stability of Plasma

15193 (COO-1478-2) MICROINSTABILITIES IN INHOMOGENEOUS PLASMA. Progress Report, May 1, 1966-January 31, 1967. Kammash, T. (Michigan Univ., Ann Arbor. Dept. of Nuclear Engineering). Contract AT(11-1)-1478. 9p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A dispersion equation for electromagnetic oscillations in anisotropic magnetized plasma incorporating density, temperature, and magnetic field gradients was used for investigating these instabilities. The simultaneous effect of gradients on oscillations near integral multiples of the ion cyclotron frequency was investigated. Initial results are presented. (M.O.W.)

15194 (MATT-496) WEAK TURBULENCE IN A HOMOGENEOUS PLASMA. Davidson, Ronald C. (Princeton Univ., N. J. Plasma Physics Lab.). Nov. 1966. Contract AT(30-1)-1238. 140p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The problem of weak plasma turbulence is considered within the framework of the B-B-G-K-Y hierarchy of equations for a fully ionized, magnetic field-free, spatially homogeneous, ensemble of slightly unstable (in velocity space), multispecies, plasmas. The hierarchy equations, utilizing the Bogoliubov-Krylov multiple time-scale technique, are expanded in the small parameter ϵ_q where $1 \gg \epsilon_q \sim \psi_k/nmv_{av}^2 \sim \gamma_k/\omega_k \gg \epsilon_p$. The quantity ψ_k is the wave energy density associated with the unstable modes; nmv_{av}^2 represents the particle kinetic energy density; γ_k is a linear growth rate typical of the unstable modes and, ω_k the associated oscillation frequency. The quantity ϵ_p is the usual plasma parameter ($1/\epsilon_p \sim$ the number of particles in a Debye sphere). In the analysis, which is carried out to order ϵ_q^2, closure of the hierarchy equations is obtained by ordering out the irreducible four-particle correlations. (auth)

15195 (MATT-507) COLLISIONAL DRIFT INSTABILITY IN NON-ISOTHERMAL PLASMAS. Hendel, H. W.; Politzer, P. A. (Princeton Univ., N. J. Plasma Physics Lab.). Feb. 1967. Contract AT(30-1)-1238. 19p. (CONF-670104-3). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Conference on Physics of Quiescent Plasmas, Frascati, Italy.

The presence of the collisional drift instability in alkali plasmas was demonstrated. The identification of this instability was aided by the recognition of the effect of a radial electric field, causing a plasma rotation. The principal result of this work is the consistent observation of a single dominant mode for any given set of experimental parameters, and of transitions from one dominant mode to another when magnetic field, plasma density, plasma temperature, or ion mass is varied. (auth)

15196 (MATT-522) OSCILLATIONS AND DIFFUSION IN A SHEAR STABILIZED Q-MACHINE. Chen, Francis F. (Princeton Univ., N. J. Plasma Physics Lab.). Feb. 15, 1967. Contract AT(30-1)-1238. 28p. (CONF-670104-4). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Conference on Physics of Quiescent Plasmas, Frascati, Italy.

Recent theoretical work has indicated the importance to plasma stability and confinement of universal collisionless instabilities, resistive drift modes, collisionless quasimodes, and resistive quasimodes. These instabilities are investigated in a thermally ionized potassium plasma. The effects of magnetic shear on these waves and on diffusion are investigated. (M.O.W.)

15197 EXCITATION OF ELECTROMAGNETIC OSCILLATIONS IN A PLASMA BEAM BOUNDED BY PLANE CONDUCTING WALLS. Bakanov, S. P.; Bogdankevich, L. S.; Rukhadze, A. A. (Lebedev Inst. of Physics, Moscow). Zh. Tekh. Fiz., 36: 1639-48(Sept. 1966). (In Russian).

An investigation was made on the stability of a plasma uniformly filling most of the space between two plane parallel conducting walls and carrying an electron current in the direction of an applied magnetic field that is parallel to the walls. The calculations were undertaken because of their practical interest in connection with negative absorption amplifiers and plasma betatrons. The walls were assumed to be plane and parallel to facilitate the calculations; it is presumed that the results are qualitatively valid for the technically interesting case of a plasma beam in a cylindrical enclosure with conducting walls. The calculations are based on a dielectric tensor derived by linearizing hydrodynamic equations for the electron motion, which include the self-consistent field and the effects of collisions. The calculations are, therefore, valid for waves whose phase velocities are high compared with the electron thermal velocities. Dispersion equations are derived for the limiting cases of weak and strong external magnetic field, and the logarithmic increments of the oscillations are calculated. It is found that in a rarefied plasma in a weak magnetic field there develops a periodic convective instability that is carried by the electron current, and that such a system can amplify. The instability persists in a weakly ionized dense plasma, in which collision effects are predominant, and a strong external longitudinal magnetic field reduces the logarithmic increment in a collision-free plasma but does not stabilize it. The frequency band that can be amplified increases in width with increasing wall conductivity, but the length of the tube required for a given gain also increases. It is concluded that the optimum wall conductivity for a negative absorption amplifier is 10^{13} or 10^{14} sec^{-1} and the optimum plasma density is such as to provide a collision frequency of 10^{12} or 10^{13} sec^{-1}. Under these conditions frequencies up to about 10^{12} Hz can be amplified. It is found that under the conditions of the plasma betatron experiments of A. M. Stefanovskii, the instability discussed here develops during the course of several microseconds. This time is much longer than the observed acceleration times and is also longer than the time that would be required for acceleration of the electrons if the acceleration were not interrupted. It is therefore concluded that the instability associated with wall conductivity cannot explain the observed interruption of acceleration in the plasma betatron and will not in itself prevent the operation of such an accelerator. (ATD)

15198 ANOMALOUS PLASMA TRANSPORT IN rf DISCHARGES. Powers, E. J.; Mumola, P. B. (Univ. of Texas, Austin). Phys. Lett., 24A: 220-1(Feb. 13, 1967).

The growth criterion for an ion-acoustic instability predicts a critical magnetic field dependence on pressure p, tube radius R, and mass m_i, which is in good agreement with the experimental observations in the low-pressure rf discharge. (auth)

15199 PLASMA WAVE EXCITATION AND THERMALIZATION IN AN ELECTRODELESS INDUCTION DISCHARGE. El-Khalafawy, T. A.; Souprunenko, V. A.; Ternopole, A. M.; Bourham, M. A. (Atomic Energy Establishment, Egypt). Phys. Lett., 24A: 233-4(Feb. 13, 1967).

Plasma instabilities arising from plasma wave excitation instabilities arising from plasma wave excitation in strong electric and magnetic crossed fields are discussed. These instabilities were found to lead to effective plasma electron heating. (auth)

15200 DYNAMICS OF QUASILINEAR RELAXATION IN AN UNSTABLE INHOMOGENEOUS PLASMA. Ivanov, A. A.; Markeev, B. M.; Rudakov, L. I. Zh. Eksp. Teor. Fiz., 52: 594-603(Feb. 1967). (In Russian).

The dynamics of quasilinear relaxation of an unstable distribution function is considered for the case of potential drift waves for $T_e \gg T_i$. It is shown that the narrow wave packet produced as a result of growth in accordance with the linear theory shifts toward smaller wave lengths. The time variation law of the mean wave number of the packet is established. It is shown that the packet remains narrow. The property of the nonlinear increment, which consists in suppression of oscillations of longer wave length by the disturbance with a given wave vector value and in a weak effect on the short wave part of the spectrum, is true for other types of drift instabilities and in particular for $T_e \sim T_i$. (auth)

15201 SPATIAL DEVELOPMENT OF PLASMA BEAM INSTABILITY. Levitskii, S. M.; Shashurin, I. P. Zh. Eksp. Teor. Fiz., 52: 350-6(Feb. 1967). (In Russian).

The spatial distribution of the oscillation intensity and spectrum along an experimental lamp in which the electron beam interacts the plasma produced by it is investigated. In this case all stages of the interaction between the beam and plasma described by the quasilinear theory can be observed as a spatial pattern along a lamp operating under stationary conditions. Concurrent with an increase of the intensity and broadening of the oscillation spectrum the electron energy distribution function in the beam was found to broaden out. With increase of the beam current the rate of spatial development of the oscillations and deformation of the beam electron energy distribution function also increases. (auth)

15202 INVESTIGATION OF A TURBULENT PLASMA DURING ION-ACOUSTIC INSTABILITY. Buchel'nikova, N. S.; Salimov, R. A.; Eidel'man, Yu. I. Zh. Eksp. Teor. Fiz., 52: 387-96(Feb. 1967). (In Russian).

The state of the plasma and its diffusion across a magnetic field during ion-acoustic instability excited by a current is investigated. It is found that the amplitude of the density oscillations is comparable with the density itself ($\tilde{n}/n \sim 1$). The plasma state is turbulent and the correlation of the oscillation phases is maintained during ~10 to 15 periods. The diffusion coefficient sharply increases during excitation of the instability. For amplitudes such that $\tilde{n}/n \sim 1$ the diffusion coefficient is inversely proportional to magnetic field

strength and for H = 1000 Oe it is $(1.5 \pm 0.3) \times 10^3$ cm²/sec, that is, it is close to the Bohm value, 2.2×10^3 cm²/sec. (auth)

15203 PARAMETRIC INSTABILITY IN PLASMA-MODULATED BEAM INTERACTION. Shapiro, V. D. At. Energ. (USSR), 22: 44-6(Jan. 1967). (In Russian).

Following up previous studies concerning the stabilization of the beam instability by means of plane modulation of the plasma, the instability caused by parametric resonance, arising from the interaction of the modulated beam with the plasma, was investigated. The case considered related to the stationary situation, in which the beam acts on a compensated-charge plasmoid cluster moving with a constant speed. From the generalized dispersion equation the frequency difference was calculated; this was allowed to derive formulas for the beam instability spectrum and increments. It was found that the maximum value of the growth increment of the oscillation in the case of parametric instability is of the same order of magnitude as the increment maximum in the case of beam stability. (TTT)

15204 VARIATIONAL STUDY OF THE RUNAWAY INSTABILITY IN A TWO-COMPONENT PLASMA. Nicolis, G.; Sels, Ph. (Univ. Libre, Brussels). Phys. Fluids, 10: 414-17(Feb. 1967).

The local potential variational method recently introduced by Prigogine and Glansdorff is applied to the study of the stability of a kinetic equation. The problem of runaway instability of a two-component plasma is especially considered and an expression for the critical field is derived. This expression explicitly takes account of the dissipative processes both in the steady state and in the perturbation from it. The relationship to the results by Dreicer et al. is briefly discussed. (auth)

15205 EFFECT OF ION COLLISIONS AND OTHER TERMS ON THE RESISTIVE-g INSTABILITY IN PLASMAS. Stringer, T. E. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Phys. Fluids, 10: 418-27(Feb. 1967). (CLM-P-110).

The treatment is based on guiding center equations, which include collisional diffusion across the magnetic field lines. The eigenvalues of the resulting differential equations are found using phase integral methods. The localized resistive-g mode becomes stable at sufficiently low collision frequencies, the dominant stabilizing mechanism depending on the shear. For strong magnetic shear [shear length < radius of curvature of field lines × $\frac{1}{4}(M/m)^{\frac{1}{4}}$] ion collisional effects are found to first produce stability, whereas for weak magnetic shear the dominant effect comes from the electron acoustic term in Ohm's law. Analytic stability criteria are derived which show satisfactory agreement with a recent numerical solution of the same problem, but underline the danger of extrapolation based on the numerical solution. (auth)

15206 STABILIZATION OF HELICAL MODES BY MAGNETIC WELLS. Fowler, T. K. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Fluids, 10: 469-70 (Feb. 1967).

Helical modes are found to be stabilized by magnetic wells of finite but small depth, and thus provide a practical test of the general principle of stabilization by deep wells. (auth)

15207 VELOCITY SPACE INSTABILITIES IN A TOROIDAL GEOMETRY. Berk, H. L.; Galeev, A. A. (International Atomic Energy Agency, Trieste, Italy). Phys. Fluids, 10: 441-50(Feb. 1967).

A self-consistent equilibrium is derived for a simple toroidal model from knowledge of the particle orbits. This equilibrium is investigated for velocity space instabilities analogous to the loss cone of mirror machines. An ion instability generated by particles in "trapped" or nearly "trapped" orbits is found when the rotational transform is relatively weak, but is stabilized with larger rotational transform. Instability is also found at the plasma edge due to a loss of particles in a preferred region of velocity space. A qualitative discussion of the quasi-linear development of these instabilities is presented. (auth)

15208 EFFECT OF PRESSURE ON NEGATIVE V'' STELLARATORS. Johnson, John L. (Princeton Univ., N. J.). Phys. Fluids, 10: 451-3(Feb. 1967).

Stability with respect to hydromagnetic interchanges can be achieved in closed configurations if $V''(\psi) < 0$ with $V''(\psi)$ the volume inside a magnetic surface of flux ψ. A low-pressure expansion is used to examine the effects of plasma currents in a negative V'' configuration which utilizes an l = 2 shaping field and an l = 1, l = 3 corrugating field and in which toroidal curvature is neglected. Numerical calculations indicate that the effect on stability of these currents is small. Since the basic features of all the proposed negative V'' configurations are similar, this strengthens the belief that vacuum field considerations provide an adequate approximation. (auth)

15209 CONVECTIVE AND ABSOLUTE HARRIS INSTABILITIES. Beasley, C. O. Jr. (Oak Ridge National Lab., Tenn.). Phys. Fluids, 10: 466-7(Feb. 1967). (ORNL-P-2673).

It has been found that, for some ranges of plasma parameters, the Harris modes associated with the non-Maxwellian ion distributions characteristic of energetic injection experiments change from convective to absolute with increasing density. (auth)

15210 NON-LINEAR THEORY OF INSTABILITY OF NON-POTENTIAL PLASMA WAVES IN AN OSCILLATING DISCHARGE. Vaclavik, J. (Inst. of Plasma Physics, Prague). Czech. J. Phys., 17: 133-41(1967).

An analysis is presented of the nonlinear effects produced by the instability of nonpotential plasma waves in an oscillating discharge. An equation is derived to describe a stationary weakly turbulent state of the plasma, with the aid of which an estimate is made of the spectrum function of the electric field of the waves, and of the coefficient of turbulent diffusion of the plasma. (auth)

Shielding

15211 (LA-3619) EFFECTIVE TWO-GROUP GAMMA-RAY SPECTRA FOR THERMAL NEUTRON CAPTURE AND PROMPT FISSION. Dudziak, Donald J. (Los Alamos Scientific Lab., N. Mex.). Oct. 1966. Contract W-7405-eng-36. 64p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Effective two-group gamma spectra were determined for thermal neutron capture in sodium, nickel, type-304 stainless steel, and tantalum, as well as for ^{235}U prompt fission gamma rays. The absorbed dose due to uncollided and built-up fluxes in several materials was calculated for varying thicknesses of several intervening shielding materials. A seven-group compilation of capture gamma rays and an analytical fit to the prompt fission gamma spectrum were used as the basis for this study. The resulting function for each combination of shielding and absorbing material was reduced to two exponential functions for areal density ranges with upper limits as great as 560 g/cm². These effective spectra reproduce, to within an average absolute deviation of less than 7.4%, the absorbed doses (uncollided and built-up) calculated by the detailed spectra, within the ranges of areal density considered. (auth)

15212 (N-66-39691) SPACE RADIATION SHIELDING WITH THE MAGNETIC FIELD OF A CYLINDRICAL SOLENOID. McDonald, P. F.; Buntyn, T. J. (Brown Engineering Co., Inc., Huntsville, Ala. Research Labs.). June 1966. Contract NAS8-20166. 68p. (NASA-CR-78934). CFSTI $3.00 cy, $0.65 mn.

The charged-particle radiation shielding characteristics of magnetic fields generated by right circular solenoids are analyzed using Störmer's theory. Allowed and forbidden regions for unbound particle motion are obtained and shielded volumes are presented in parametric form. The results are applicable over a wide range of particle energies and solenoid parameters through the Störmer transformation. (auth)

15213 (USNRDL-TR-1045) EXPERIMENTAL AND CALCULATED ESTIMATES OF THE SHIELDING EFFECTIVENESS OF COMPARTMENTED STRUCTURES EXPOSED TO FALLOUT. Shumway, B. W. (Naval Radiological Defense Lab., San Francisco, Calif.). July 19, 1966. 58p.

Exposure reduction factors were measured inside six compartmented steel structures having different wall thicknesses ranging from ¼ to 1½ in. These were exposed to radiation from fallout of varying age from three to nine days. Calculations based upon the Nelms–Cooper gamma-ray spectrum at H + 1.12 hours were made for selected compartments in each of the structures following procedures given in the Office of Civil Defense Professional Manual, PM-100-1. Comparison of experiment and calculation reveals a sensitivity to spectral changes and shows that protection is greater during the periods D + 3 to D + 9 days than at H + 1.12 hours. Overall agreement is generally satisfactory. The calculational methods for radiation through floors, however, appear to be inadequate. Spectra measured on site at D + 3 and D + 9 days are given. (auth)

15214 (ORNL-tr-1381) DEVELOPMENT OF SHIELDING CALCULATION METHODS AT THE ATOMIC ENERGY COMMISSION [FRANCE.] Devillers, C.; Lafore, P.; Rastoin, J. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Oak Ridge National Lab., Tenn., from report DEP/SEPP-485/66. 13p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80 mf.

The Monte Carlo method can be applied to all problems of reactor shielding. Certain constraints for graphite and heavy water power reactors, fast reactors, light water reactors, and radiation leaks must be resolved. Computer programs used for solving these problems are discussed. (F.S.)

15215 METHOD OF GAMMA-RAY TRANSPORT SIMULATION IN INHOMOGENEOUS MEDIA. Bahr, G. K.; Jones, D. R.; Perry, H.; Kereiakes, J. G. (Univ. of Cincinnati). Radiat. Res., 29: 166-83(Oct. 1966).

For the energy range 10 keV to 1.5 MeV, in materials of low to average Z, γ-ray transport has been reduced, from a computational point of view, to appropriate transformations on a photon library, by means of a processing program. The latter employs decision tables which take into account the geometric and physical properties of specific classes of problems. This simple representation is made possible as a consequence of the basic scattering theory governing the processes that can occur. The alteration of the spatial distribution of the elementary events responsible for energy deposition, by virtue of inhomogeneities, is spatially a conformal transformation. Changes in energy deposition below the photoelectric threshold are accounted for by recalculation of the associated survival probabilities. The method developed is useful in that repeated Monte Carlo calculations are eliminated, and it is flexible, since in principle arbitrary source configurations and inhomogeneous geometries can be simulated on a computer of modest size. (auth)

Solid-State Physics

Refer also to abstracts 14450, 14827, and 15376.

15216 (LYCEN-6654) ETUDE DES EFFETS DIRECTIONNELS CRISTAL DE SILICUM. (Study of Directional Effects in Transmission of Protons Through A Silicon Monocrystal). Remillieux, Joseph (Lyon Univ. (France). Institut de Physique Nucleaire). Nov. 1966. 122p. (In French). Dep. mn.

Thesis.

The channeling effects undergone by protons in a silicon monocrystal were studied. A mechanical device having the angular precision necessary to locate the incident beam in the crystalline lattice and to put in operation a high-resolution detection chain making possible the fine study of the channeled beams was developed. A detailed analysis then was made of the channeling existing in the principal directions of axes and planes of a crystal of 20 μ thickness. The analysis was made under the double aspect of the intensity and the energy distribution of the transmitted beams. The results obtained are in good agreement with the classical theory of channeling. The importance of the different multiple scattering processes was confirmed by a photographic method. Experimental results were also given with respect to particles undergoing abnormally high energy losses in certain directions. A classical theory of channeling and different experiments which have shown the effect of crystalline lattices on the movement of a charged particle are reported. (J.S.R.)

15217 (N-66-34630) STUDY OF LITHIUM MOBILITY IN IRRADIATED SILICON. Hackler, Walter A.; Kikuchi, Chihiro (Michigan Univ., Ann Arbor. Dept. of Nuclear Engineering). July 1966. 106p. (NASA-CR-77303). CFSTI $3.00 cy, $0.65 mn.

Thesis.

The effect of fast-neutron- and electron-induced defects on the diffusion properties of lithium in silicon is determined experimentally by irradiating lithium-diffused diodes and subsequently applying a reverse bias to the junction at a constant temperature. Experimental results show that fast-neutron- and 0.9-MeV-electron-induced vacancies provide sites for the precipitation of lithium. Moreover, the lithium vacancy precipitate behaves like a solute in equilibrium ions and ionized vacancies. The analysis of the lithium vacancy precipitate in this fashion is analogous to the analysis of slightly soluble salts in water. It also is shown that the motion of lithium in silicon was not affected by slow-neutron irradiation. (auth)

15218 (N-66-35227) ANNEALING OF FAST NEUTRON DAMAGE IN IMPURITY-CONDUCTING N-TYPE GERMANIUM. Wolf, E. L.; Compton, W. Dale; Depp, S. W. (Illinois Univ., Urbana. Dept. of Physics). 1966. 16p. (NASA-CR-77483). CFSTI $3.00 cy, $0.65 mn.

Thermal annealing of fast-neutron-induced changes in the electrical properties of highly doped, non-degenerate, n-type germanium was investigated. Samples were irradiated for six hours by a neutron flux of approximately 4×10^{14}/cm^2. They were then annealed at 10°C intervals from 100 to 380°C, 45 minutes at each temperature. Data are presented in graph form for the resistivity vs 1/T relation, and for the fraction unannealed. The results found are: a lack of major annealing below 300°C of all quantities except the scattering center concentration; gradual annealing and then a distinct anneal stage at 275°C; and the failure of the carrier concentration to anneal completely. Reasons for results different from those obtained by gamma radiation are suggested. It is further suggested that the sharp annealing stage at 310°C is more likely the breakup of some complex of simple defects with the abundant antimony than the breakup of disordered regions. (STAR)

15219 (N-66-39440) ENERGY REQUIRED TO PRODUCE AN ELECTRON-HOLE PAIR IN SILICON BY TRITONS. Smithbrick, John J.; Myers, Ira T. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Oct. 1966. 17p. (NASA-TN-D-3694). CFSTI $3.00 cy, $0.65 mn.

The energy required to produce an electron–hole pair in silicon by tritons was measured using a sandwich configuration of two silicon surface-barrier detectors with a lithium-6 layer between them. The tritons were generated by the lithium-6 (n,α) triton reaction by using thermal neutrons. The measured value of 3.58 ± 0.04 electron volts per electron–hole pair agrees within the experimental error with the energy required to produce an electron–hole pair by alpha particles in silicon. (auth)

15220 (NYO-2150-24) PARAMAGNETIC RESONANCE OF THE $^2E(3d^3)$ LEVEL IN MgO. Chase, Lloyd Lee (Cornell Univ., Ithaca, N. Y. Materials Science Center). Feb. 1967. Contract AT(30-1)-2150. 98p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

Electron paramagnetic resonance has been performed in the excited ^2E level of the ions Cr^{3+} and V^{2+} in the cubic coordination of MgO. The resonances were detected by means of the change in circular polarized fluorescence from ^2E along the applied magnetic field as a result of microwave saturation in this state. The observed resonances have a greatly anisotropic width, which is explained in terms of the combined effects of magnetic orbital interactions and local strains, both of which split the orbital degeneracy of ^2E. The magnitude and anisotropy of the resonance width fit closely to calculations of the magnetic splitting of ^2E using parameters obtained from optical investigations of these ions by other investigators. The resonances of Cr^{3+} showed sample-dependent asymmetries which are explained as resulting from selection rules for the circular polarized fluorescence from the strain-split orbital states at each site. The details of relaxation between the components of ^2E also play a role in this regard, and it is shown that greatly distorted resonances are expected for the case of direct process relaxation due to photons. The sample dependence of these effects is correlated with cross relaxation, which is evident from measured spin-lattice relaxation data. The nature of the cross relaxation is discussed on the basis of the evidence presented by the observed resonance shapes. A well-resolved hyperfine spectrum is observed for V^{2+} from which the orbital hyperfine contribution may be obtained. The measured orbital hyperfine constant is found to agree within a few percent with the value calculated from the measured g shift and $\langle r^{-3} \rangle_{3d}$ obtained from the free ion Hartree–Fock wave functions for V^{2+}. (auth)

15221 TRIPLET SPECTRUM OF IRRADIATED POLYOXYMETHYLENE. Yamaguchi, Shigeatsu; Kaneko, Motozo; Furuichi, Jiro (Hokkaido Univ., Sapporo). J. Phys. Soc. Jap., 22: 348-9 (Jan. 1967).

Electron spin resonance spectra of irradiated polyoxymethylene have been studied and the triplet spectrum was specified to the radical $(-CH_2-O-CH_2)$. Recently, it has been reported that this triplet spectrum shows fine structure. An attempt was made to observe the new structure in detail, and to verify that the new structure is related to the molecular motion in the high polymer solid. (W.D.M.)

15222 MEASUREMENT OF MICROGRAM SURFACE DENSITIES BY OBSERVATION OF PROTON PRODUCED X RAYS. Christensen, L. J.; Khan, J. M.; Brunner, W. F. (Univ. of California, Livermore). Contract W-7405-eng-48. Rev. Sci. Instrum., 38: 20-3(Jan. 1967). (UCRL-70006).

X-ray production by proton bombardment was used to determine the surface density of thin films of Al, Cu, and Yb. This was accomplished by comparison at a number of thicknesses with known films. In addition, the x-ray yield for Al was compared with values predicted by the use of x-ray production cross section, stopping power, and bulk density. The experimental and calculated values agreed within 15%. The data are presented in linear form from 0 to 1900 Å and semilogarithmic form from 0 to 7000 Å, which is nearly a thick film for this technique. The useful upper limit lies in the range of 1000 Å for Yb and 4000 Å for Al. The lower limit is not clearly established, although the measurements for the Al surface densities were limited to surface densities equivalent to 1.2 Å as established by substrate contamination. (auth)

15223 EXCHANGE INTEGRAL IN RARE-EARTH METALS. Milstein, Frederick; Robinson, Lawrence Baylor (Univ. of California, Los Angeles). Phys. Rev. Lett., 18: 308-9(Feb. 27, 1967).

Calculations of 4f–6s electron exchange integrals were made

in order to determine the sign of the exchange integral and the dependence of the integral upon interatomic distance. The exchange integral is found to be positive in sign, and insensitive to changes of interatomic distance. By contrast, the magnetic interactions in rare-earth metals are quite sensitive to changes of interatomic distances in the crystal; it is concluded that this sensitivity is not attributable to variations of the exchange integral. (auth)

15224 LINE SHAPE PROBLEM IN NUCLEAR MAGNETIC RESONANCE. Evans, W. A. B.; Powles, J. G. (Univ. of Kent, Canterbury, Eng.). Phys. Lett., 24A: 218-19(Feb. 13, 1967).

A solution is given of the nuclear magnetic resonance line shape problem for static dipolar interaction. Good agreement is found between the theory and experiment for the ^{19}F signal in calcium fluoride. (auth)

15225 EFFECT OF 4.5-MeV ELECTRON BOMBARDMENT AT LIQUID NITROGEN TEMPERATURE ON THE ELECTRICAL BEHAVIOR OF P-TYPE GERMANIUM. Persin, Mirjana (Purdue Univ., Lafayette, Ind.). Glas. Mat.-Fiz. Astron., Ser. II, 20: 277-86(1965).

An attempt was made to get more information about the nature of the defects introduced and to determine the charge state of the bombardment-induced electron traps at 78°K. The experimental setup allowed measurements of the Hall coefficient, conductivity, and temperature to be completed for one data point in 4 to 5 min. Temperature variation during bombardment was not more than 2°K. Isochronal annealing experiments immediately after irradiation indicate that there is no dependence of temperature, at which the traps start to disappear, on the initial hole concentration. It is concluded that the defects are not just isolated Frenkel pairs, but that some associations of bombardment-induced defect centers and oppositely charged impurities or defects are also possible. (W.D.M.)

15226 PARAMAGNETIC RESONANCE OF F_2^- IONS TRAPPED IN ELECTRON-IRRADIATED POTASSIUM BIFLUORIDE. Otto, Fred B.; Gilliam, O. R. (Univ. of Connecticut, Storrs). Phys. Rev., 154: 244-9(Feb. 10, 1967).

Electron spin resonance (ESR) spectra attributed to F_2^- molecular ions located at two inequivalent anion sites were observed at 9.2 Gc after electron bombardment of single crystals of potassium bifluoride (KHF_2) at 77°K. The molecular axis of the F_2^- ion lies along [110] or along [1$\bar{1}$0], and the spectrum for each site consists of four hyperfine resonances. They derive from a hole interacting equally with two nuclei of spin ½, giving an effective nuclear spin of 0 or 1 and a highly anisotropic A tensor. For z||[110], x||[001], and y||[1$\bar{1}$0], components of the g and A tensors for 77°K are $g_z = 2.0020 \pm 0.001$, $g_x \approx g_y = 2.0168 \pm 0.001$, $A_z = 955.4 \pm 1$ G, and $A_x \approx A_y = 21 \pm 4$ G. At room temperature $g_z = 2.0024 \pm 0.001$, $g_x \approx g_y = 2.0180 \pm 0.0015$, $A_x = 928.8 \pm 1$ G, $A_z = 35.5 \pm 1$ G, and $A_y = 25.5 \pm 3$ G. The crystal changed from colorless to intense green upon electron irradiation, with optical absorption bands at 2.0 and 4.1 eV. As the sample was brought to room temperature, the 2.0-eV band rapidly annealed, whereas the 4.1-eV band showed annealing behavior similar to the spin resonances, remaining about two days. The ESR spectra resulted from electron irradiations with electron energies as low as 0.15 MeV, but not from a 10^6-R dose of ^{60}Co gamma rays. (auth)

15227 MAGNON SCATTERING OF POLARIZED NEUTRONS BY THE DIFFRACTION METHOD: MEASUREMENTS ON MAGNETITE. Alperin, H. A. (Naval Ordnance Lab., Silver Spring, Md. Brookhaven National Lab., Upton, N. Y.); Steinsvoll, O.; Nathans, R.; Shirane, G. Contract AT(30-2)-Gen-16. Phys. Rev., 154: 508-14(Feb. 10, 1967). (BNL-10455).

The acoustic branch of the spin-wave spectrum of a ferromagnet may be measured by the inelastic scattering of neutrons. It is shown that when polarized neutrons are employed in conjunction with the diffraction method, data may be secured over a sufficient range of the magnon wave vector q to test the applicability of the Heisenberg model. The procedures for utilizing this technique are described. In particular, the methods used for correcting for the instrumental resolution and for converting the data into the form of a dispersion relation are explained. This procedure has been applied to the study of Fe_3O_4 at room temperature for values of q/q_{max} up to ~0.3. The results are in very good agreement with measurements by direct energy analysis and with the predictions of the Heisenburg theory. A value of 2.35×10^{-3} eV is obtained for the exchange integral. Additional data taken at 77°K show that the dispersion relation in magnetite is substantially the same in the high- and low-temperature phases (i.e., above and below the A–B site ordering transition at 119°K). (auth)

15228 MULTIPLE-PULSE NUCLEAR-MAGNETIC-RESONANCE TRANSIENTS OF ^{129}Xe AND ^{131}Xe IN SOLID XENON. Warren, William W. Jr.; Norberg, R. E. (Washington Univ., St. Louis). Phys. Rev., 154: 277-86(Feb. 10, 1967).

Transient nuclear free-precession signals have been investigated for ^{129}Xe and ^{131}Xe in solid xenon. Coherent radiofrequency pulses with controlled phase differences were used to produce "solid" echoes and "quadrupole" echoes, which provide information about static dipolar and quadrupolar interactions in the solid. "Conventional" ^{131}Xe echoes formed by rephasing in the external magnetic-field inhomogeneity were observed at temperatures for which the central transition of the ^{131}Xe spectrum is motionally narrowed by self-diffusion. The temperature dependence of the data is consistent with the correlation times for self-diffusion obtained in previous ^{129}Xe experiments. (auth)

15229 MOESSBAUER EFFECT FOLLOWING COULOMB EXCITATION OF ^{57}Fe. Ritter, E. T.; Keaton, P. W. Jr.; Lee, Y. K.; Stevens, R. R. Jr.; Walker, J. C. (Johns Hopkins Univ., Baltimore). Phys. Rev., 154: 287-91(Feb. 10, 1967).

Recoilless gamma-ray emission has been observed in ^{57}Fe following Coulomb excitation by 3.0-MeV α-particle bombardment of iron nuclei in α-iron and Fe_2O_3 lattices. Within experimental error, the Mössbauer fraction following Coulomb excitation in α iron is not reduced as compared with that observed in ^{57}Co source data, whereas in the case of the oxide a reduction in the recoilless fraction by a factor of 2 is observed. In both the metallic and oxide data, the respective hyperfine splittings do not deviate by more than a few percent from the values obtained from ^{57}Co source data for α iron and Fe_2O_3, respectively. There is no indication in any of the Coulomb excitation data of isomer shifts differing from the shifts observed in ^{57}Co source data. These results are interpreted in terms of extensive replacement collisions. (auth)

15230 NEUTRON SPECTROSCOPY OF SOLIDS. PART II. Lomer, W. M. (Atomic Energy Research Establishment, Harwell, Eng.). Contemp. Phys., 7: 401-18(Nov. 1966).

A survey is given of current applications of neutron scattering in elucidating the microscopic properties of both magnetic and non-magnetic materials. Magnetic spin-wave investigations, the properties of phase-change critical points, and the elastic scattering from nonmagnetic and magnetic defects are described. Quantum mechanics provides the natural framework for the discussions, and with its help unambiguous results are obtained on some of the main problems of energy levels and dynamics of crystals. (W.D.M.)

15231 SCATTERING OF SLOW NEUTRONS BY POLYCRYSTALLINE SELENIUM AND TELLURIUM. Axmann, A.; Gissler, W. (Kernforschungsanlage, Juelich, Ger.). Phys. Status Solidi, 19: 721-7(Feb. 1, 1967). (In German).

The inelastic scattering of slow neutrons by polycrystalline selenium and tellurium is studied using a rotating crystal spectrometer. The frequencies of the observed transitions are consistent with the results of infrared spectroscopy, but the number of transitions is lower, which indicates that many of the infrared transitions are combinations. The tellurium spectrum is in good agreement with Hulin's theory. The neutron spectra of the two isomorphous lattices are similar. (auth)

15232 EFFECT OF DIVALENT CATION IMPURITIES ON THE FORMATION AND BLEACHING OF COLLOIDS IN NaCl. Ikeda, Toshio; Yoshida, Shigetomo (Tohoku Univ., Sendai). J. Phys. Soc. Jap., 22: 138-43(Jan. 1967).

A study of the effect of Cd, Pb, and Mn on the formation of colloids in NaCl by electron irradiation was made by the measurement of optical extinction spectra. The concentration and particle size of colloids were estimated by comparing the extinction curves with the results calculated by Savostianowa. The observed spectra show that the concentration of colloids increases and the particle size decreases as the concentration of divalent cation impurity increases. A simple theory of the effect of divalent cation impurities on the formation of colloids is described in relation to the nucleus and the process of coagulation. The thermal bleaching of colloidal coloration was also investigated in both the pure and the impurity-doped regions. The bleaching of colloidal coloration is more remarkable in the region of higher concentration of divalent cation impurity. (auth)

15233 NUCLEAR MAGNETIC RESONANCE AND SPECIFIC HEAT MEASUREMENTS OF TRANSITION METALS AND ALLOYS: Ti–V–Fe AND Zr–Nb–Mo SYSTEMS. Masuda, Yoshika (Kobe Univ., Japan); Nishioka, Masahiro; Watanabe, Naoko. J. Phys. Soc. Jap., 22: 238-47(Jan. 1967).

The nuclear spin-lattice relaxation times (T_1) of ^{51}V and ^{93}Nb in the body-centered-cubic Ti–V–Fe and Zr–Nb–Mo alloy systems were measured. The product of T_1 and temperature T, T_1T, is strongly dependent upon composition. These relaxation behaviors can be correlated to low-temperature specific heat. The Knight shifts of ^{93}Nb nuclear magnetic resonance in

Zr–Nb–Mo alloy systems were also measured. The composition dependence of the Knight shift can be related to the relaxation result as well as to the results on low temperature specific heat and magnetic susceptibility. The electronic specific heat coefficient γ of Zr–Nb alloys was measured for the sake of interpretation of the experimental behavior of T_1 and Knight shift. (auth)

15234 LIFE TIME OF EXCITED STATE OF F CENTERS IN KCl:Ag. Shimada, Toshikazu; Okuno, Takeshi; Ishiguro, Masakazu (Osaka Univ.). J. Phys. Soc. Jap., 22: 349-50(Jan. 1967).

An experiment on the decay of the F luminescence in KCl:Ag was carried out by the use of a pulsed light of about 3×10^{-6} sec duration. The F center was formed by x-ray irradiation at room temperature and its concentration was about 3×10^{16} cm^{-3}, assuming the oscillator strength of 0.8. Curves of the decay time vs. the Ag^+ ion concentration and the pulse height of the luminescence are shown. (W.D.M.)

15235 SECOND QUANTIZATION AND ATOMIC SPECTROSCOPY. (G. H. Dieke Memorial Lectures). Judd, Brian R. Baltimore, Johns Hopkins Press, 1967. 69p. $5.95. (UCRL-16098(Rev.)).

Although no explicit reference is made to crystal spectra, the motive for much of the analysis presented here stems from the desire to reduce as far as possible the theoretical apparatus for handling the spectra of rare-earth and actinide atoms. It is assumed that the reader has a working knowledge of the tensor-operator methods of Racah. It is against this conventional background that the advantages of the method of second quantization become apparent. The gain derives chiefly from the use of annihilation and creation operators, which, by connecting states in adjacent configurations, provide a framework for treating in a unified and natural way not merely configurations but whole shells. Properties that depend on the number of electrons in a configuration can thus be treated simply and directly. The formalism of perturbation theory can also be simplified, since it becomes no longer necessary to specify in detail the intermediate states in the calculation of a string of matrix elements. (auth)

Theoretical Physics

Refer also to abstract 14931.

15236 COULOMB FIELD AND NONRELATIVISTIC QUANTIZATION OF SPACE. Mir-Kasimov, R. M. Zh. Eksp. Teor. Fiz., 52: 533-5(Feb. 1967). (In Russian).

The possibility of describing the hydrogen atom in terms of the geometry of constant-curvature p space is considered. An analogy with Snyder quantization of space is drawn. Various ways of projective introduction of the metric into p space are investigated. (auth)

15237 SOLAR OBLATENESS AND GENERAL RELATIVITY. Dicke, R. H.; Goldenberg, H. Mark (Princeton Univ., N. J.). Phys. Rev. Lett., 18: 313-16(Feb. 27, 1967).

New measurements of the solar oblateness have given a value for the fractional difference of equatorial and polar radii of $(5.0 \pm 0.7) \times 10^{-5}$. A corresponding discrepancy of 8% of the Einstein value for the perihelion motion of Mercury is implied. (auth)

15238 MOTION OF A PARTICLE IN THE FIELD OF TWO WAVES. Verbitskii, I. L. (Inst. of Radiophysics and Electronics, Kharkov). Zh. Tekh. Fiz., 36: 1669-80(Sept. 1966). (In Russian).

The one-dimensional motion of a nonrelativistic charged particle in the field of two traveling electromagnetic sinusoidal waves with frequencies ω and 2ω, respectively, and with equal phase velocities, is analyzed. It is assumed that the initial phase velocities of both waves as well as of the charged particle are equal to zero. The final equation describing the motion of the charged particle in dimensionless coordinates is written in the form $d^2\psi/d\tau^2 = -(\beta/\omega^2)(A_1 \sin \psi + A_2 \sin 2\psi)$, where a, b, c are coefficients expressed in terms of parameters of the field of two traveling waves. The exact solution $\psi(\tau)$ of the equation in terms of elliptic (Weierstrass) functions is determined and its $\psi'(t)$ (which is also an elliptic function) is established. The behavior of the charged particle is analyzed on the basis of the expressions for $\psi(\tau)$ and $\psi'(\tau)$. For some "degenerate" cases, $\psi(t)$ is calculated in terms of elementary functions in the form of series which converge at the rate of geometric progression. The formulas derived here are convenient for calculations and make it possible to study certain physical effects caused by the nonlinearity of reference equations. The general expression for $\psi(\tau)$ is analyzed for the case of one wave and also for certain limiting cases. Asymptotic expansions for $\psi(\tau)$ are obtained for the case of small and large amplitudes of traveling waves. (ATD)

15239 LOCATABILITY OF ENERGY AND MOMENTUM OF GRAVITATIONAL FIELDS. Dehnen, H. (Univ., Freiburg i. B.). Z. Phys., 199: 360-8(1967). (In German).

It is shown that a location of energy and momentum of gravitational fields is possible by direct measurement of the gravitation field by means of suitable measurement devices. (tr-auth)

15240 MAGNETIC CHARGE. Sandars, P. G. H. (Oxford Univ.). Contemp. Phys., 7: 419-29(Nov. 1966).

The available evidence concerning the existence of magnetic charge is examined. It is found that the experimental evidence against it is very strong and that its discovery would cause considerable difficulty in conventional theoretical physics, but that no conclusive theoretical argument against its existence has yet been found. The apparent absence of magnetic charge in nature remains unexplained and rather disquieting. (auth)

15241 STATIC, AXIALLY SYMMETRIC, INTERIOR SOLUTION IN GENERAL RELATIVITY. Hernandez, Walter C. Jr. (Goddard Inst. for Space Studies, New York. Univ. of Maryland, College Park). Phys. Rev., 153: 1359-63(Jan. 25, 1967).

A static, axially symmetric, interior solution of the Einstein field equations which matches on smoothly to one of the Weyl exterior solutions is exhibited. It is obtained essentially by guessing an interior metric and requiring that the calculated stress-energy tensor not be grossly unphysical. Boundary conditions at the surface of the matter are employed which guarantee the existence of, but do not exhibit explicitly, coordinates in which the metric components and their derivatives are continuous. Finally, it is shown that this method can easily be generalized to obtain interior solutions for any Weyl metric which indicates that it has a positive mass source. (auth)

15242 HAMILTON–JACOBI QUANTIZATION OF GENERAL RELATIVITY. Komar, Arthur (Yeshiva Univ., New York). Phys. Rev., 153: 1385-7(Jan. 25, 1967).

It is shown that the family of solutions of the Einstein field equations, determined by a solution of the Hamilton-Jacobi equations, is characterized by a complete commuting set of constants of the motion. It is then pointed out that the quantization program based on the utilization of the transition from the Hamilton-Jacobi equations to the corresponding Schrödinger equations yields a quantum theory of gravitation which is "frozen" (that is, it contains no dynamics), thus suffering from the same malady as does the canonical quantization program. (auth)

15243 ADIABATIC INVARIANCE AND ADIABATIC INVARIANTS. Ter Haar, D. (Magdalen Coll., Oxford). Contemp. Phys., 7: 447-58(Nov. 1966).

It is shown how a discussion of processes slow enough to be considered adiabatic in the thermodynamic sense can be used in such widely different fields as radiation theory, quantum theory, theory of electrolytes, and plasma physics to obtain relations which have a general validity. (auth)

15244 KINETIC THEORY FOR A DILUTE GAS OF PARTICLES WITH SPIN. Hess, S.; Waldmann, L. (Univ., Erlangen-Nuernberg, Ger.). Z. Naturforsch., 21a: 1529-46(Oct. 1966).

The kinetic theory of particles with spin previously developed for a Lorentzian gas is extended to the case of a pure gas. The transport (Boltzmann) equation for the one-particle distribution operator is stated and discussed (conservation laws, H theorem). A magnetic field acting on the magnetic moment of the particles is incorporated throughout. The pertaining linearized collision operator and certain bracket expressions linked with this operator are considered. The expansion of the distribution operator and of the linearized transport equation with respect to a complete set of composite irreducible tensors built from the components of particle velocity and spin is considered. Thus, the distribution operator is replaced by a set of tensors depending only on time and space coordinates. The physical meaning of these tensors (expansion coefficients) is invoked. They obey a set of coupled first-order differential equations (transport–relaxation equations). The reciprocity relations for the relaxation matrices are stated. Finally a detailed discussion of angular momentum conservation is given. (auth)

15245 REMARKS ON THE SPACE–TIME CAUSAL AUTOMORPHISMS. Flato, Moshe; Sternheimer, Daniel (Institut Henri Poincare, Paris). Compt. Rend., Ser. A, 263: 935-8 (Dec. 19, 1966). (In French).

A theorem on the group of casual automorphisms is discussed critically and the classic action of the conformal group on Minkowski space is analyzed in relation with this critical discussion. (tr-auth)

15246 COMBINED KERR-NUT SOLUTION OF THE EINSTEIN FIELD EQUATIONS. Demianski, M.; Newman, E. T. (Univ., Warsaw. Univ. of Pittsburgh). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 14: 653-7(1966).

Recently it has been shown how to obtain the Kerr spinning particle metric and its generalization to the rotating, charged mass metric by means of a complex coordinate transformation. It is shown that the success of this complex coordinate transformation was not an isolated coincidence and that other new metrics can be so obtained. Starting with the Schwarzschild metric, an empty space metric is obtained which is a combination of the Kerr metric and the NUT space metric. The Killing vectors of this metric are given and its topology is discussed. A solution of the Einstein–Maxwell equations is given which combines the gravitational magnetic monopole with a real magnetic monopole. (W.D.M.)

15247 EFFECT OF RELATIVITY ON ATOMIC WAVE FUNCTIONS. **Burke, V. M. (Atlas Computer Lab., Chilton, Eng.); Grant, I. P. Proc. Phys. Soc. (London), 90: 297-314(Feb. 1967).**

Little attention appears to have been paid to the effect of relativity on atomic wave functions since White studied the matter in 1931. Graphs and tables are presented to show the order of magnitude of corrections to the hydrogenic charge distributions for Z = 80, and to study the systematic correction to various hydrogenic expectation values as a function of atomic number. Use of the results to predict relativistic expectation values in complex atoms, in the light of recent work by Garstang and Mayers, is discussed. (auth)

15248 ISOTROPIC SCATTERING OF RADIATION IN A FINITE HOMOGENEOUS TWO-DIMENSIONAL ATMOSPHERE. **Smith, M. G.; Hunt, G. E. (Sir John Cass Coll., London). Proc. Cambridge Phil. Soc., 63: 209-20(Jan. 1967).**

The integral equation for the isotropic scattering of radiation in a medium bounded laterally by planes $\pm y_0$ is solved as a series in powers of exp $(-y_0)$. This series is certainly convergent for y_0 large enough, and rapidly convergent for most practical purposes. Though the form of the solution is basically similar to that given for scattering in a finite sphere in an earlier paper, the method used in that paper fails in this instance, and has to be replaced by a more general method. It is shown that if terms of order exp $(-y_0)$ are neglected, the solutions of the integral equations for both infinite and finite problems appear similar. There is, however, a difference of interpretation, since one is a Fourier transform and the other a Fourier series, and the actual solutions differ by terms larger than exp $(-y_0)$. (auth)

15249 NONSTATIC ELECTROMAGNETIC FIELDS IN GENERAL RELATIVITY. **Datta, B. K. (Surendra Nath Coll., Calcutta). Nuovo Cimento (10), 47A: 568-72(Feb. 1, 1967).**

The equations of Rainich's "already unified theory" are solved for the case when the field is nonstatic and the space–time metric which admits a group G_4 of automorphisms has the structure: $[X_i, X_j] = 0$ (i, j = 1, 2, 3), $[X_1, X_4] = lX_2$, $[X_2, X_4] = mX_1$, $[X_3, X_4] = 0$, $l = m = 0, \pm 1$. (auth)

15250 PHYSICAL PRINCIPLES OF EINSTEIN'S GRAVITATION THEORY. **Fock, V. (Leningrad State Univ.). Ann. Inst. Henri Poincare, Sect. A, 5: 205-15(1966). (In French).**

The principles of general relativity and equivalence are analyzed to see if they truly form the basis of the Einstein gravitation theory. It is shown that the general relativity principle expresses no physical law and that the equivalence principle, which is purely local, is only approximated. The true basis of the Einstein gravitation theory is constituted by other principles. (J.S.R.)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer to abstracts 15479 and 15586.

Electromagnetic

15251 (CALT-68-108) PION PHOTOPRODUCTION DATA BELOW 1.5 GeV. Beale, J. T.; Ecklund, S. D.; Walker, R. L. (California Inst. of Tech., Pasadena. Synchrotron Lab.). Nov. 1, 1966. Contract AT(11-1)-68. 120p. (CTSL-42). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Data on single pion photoproduction below 1.5 GeV were collected and are presented in the form of tables and graphs. The compilation is mostly noncritical, and the numbers are those contained in the original papers. Data from different experiments were not normalized in order to obtain agreement from one experiment to another. The tables of data presented are meson (π^+) and meson (π^0) differential cross sections, meson (π^-) data, polarized photon asymmetries, and recoil polarization. The graphs include meson (π^+) angular distributions, meson (π^0) angular and energy distributions, meson (π^-) angular distributions, total and differential cross sections at 0 and 180°, and polarized photon asymmetries and polarization of the recoil nucleon. (J.F.P.)

15252 (CONF-660221-, pp 251-4) POLARISATION EFFECTS IN INELASTIC SCATTERING OF GAMMA RAYS. Raju, A. S.; Rao, J. Rama; Lakshminarayana, V. (Andhra Univ., Waltair (India)).

The prediction of the Klein-Nishina theory for polarization in the inelastic scattering of photons by electrons was tested by scattering a collimated beam of 662-keV gamma rays from a ^{137}Cs source on an Al target, collimating the scattered beam, and observing the scattering of this beam by an NaI(Tl) crystal. It was concluded that the Klein-Nishina theory predicts the polarization effects in inelastic scattering accurately at least to the first order. (D.C.W.)

15253 (DESY-66/32) PHOTOPRODUCTION OF MESON AND BARYON RESONANCES AT ENERGIES UP TO 5.8 GeV. Brall, U.; Erbe, R.; Reimann, G.; (and others) (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Nov. 1966. 47p.

In a study of photoproduction at photon energies between 0.3 and 5.8 GeV in a hydrogen bubble chamber approximately 14,000 events with three or five outgoing charged particles were analyzed. The following resonances are observed in the effective mass plots: η, ρ^0, ρ^-, ω, X^0, ϕ and f. The production cross sections for these resonances are given as a function of the photon energy. Differential cross sections for ρ^0 and ω production as well as the elements of the spin space density matrix of their decay are presented for successive energy intervals. In addition, the corresponding decay angular distributions are shown for high photon energies. The predictions of different versions of the one-pion-exchange and the diffraction model are compared with the experimental results. From the reaction $\gamma p \to N^{*++}\rho^-$ we obtain an upper limit for the partial decay width of the ρ^- meson into $\pi^-\gamma$: $\Gamma(\rho^- \to \pi^-\gamma) < 0.45$ MeV. For the 4π decay mode of the ρ meson we find an upper limit of $\Gamma(\rho^0 \to 2\pi^+ 2\pi^-)/\Gamma(\rho^0 \to \pi^+\pi^-) < 0.006$. The production cross section of the ϕ meson is given as a function of the photon energy and compared with diffraction models. The cross section for η meson production has a pronounced maximum at about 0.8 GeV photon energy, and the production angular distribution is consistent with isotropy. Photoproduction of N^{*++} (1236) was also observed in the channel $\gamma p \to N^{*++}\pi^-$. At energies below 1.1 GeV this channel dominates the reaction $\gamma p \to p\pi^+\pi^-$. At higher energies the cross section for N^* production drops rapidly, but the reaction is still observed up to 5 GeV. Total and differential cross sections for N^* production are presented as a function of the photon energy, and decay angular distributions of the N^* are given. The one-pion-exchange model with corrections for gauge invariance and for absorptive effects is compared with the experimental results. (auth)

15254 MEASUREMENT OF THE SIGMA MAGNETIC MOMENT. Sullivan, Charles Raymond. Nashville, Vanderbilt Univ., 1966. 106p.

Thesis.

A new value of the hyperon (Σ^+) magnetic moment obtained from sigmas produced in the reaction $\gamma + p \to \Sigma^+ + K^0$ using the spin precession technique is reported. Also preliminary results are given for the sigma moment from the reaction $K^- + p \to \Sigma^+ + \pi^-$. A hardened bremsstrahlung beam of 1500-MeV peak energy was used for the first reaction, and a separated beam of mesons (K^-) of momentum 1150 MeV/c was used for the latter reaction. (J.F.P.)

Weak

15255 (COO-881-96) ISOTOPIC SPIN DECOMPOSITION OF THE AMPLITUDES FOR $K \to 2\pi$. Cline, David (Wisconsin Univ., Madison). Jan. 1967. Contract AT(11-1)-881. 10p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The possibility of determining the magnitudes and phases of the amplitudes for isotopic spin transitions $\Delta T = I/2$ where $I = 1$, 3, and 5 is discussed. It is found that such a decomposition is possible provided that the phase angle of the amplitude for $K^+ \to \pi^+ + \pi^0$ can be measured. The possibility of measuring this phase angle using the decay modes $K^\pm \to \pi^\pm\pi^0\gamma$ is discussed. Finally, a set of amplitudes is suggested that are consistent with all experimental data and which exhibit nearly maximal CP violation for the $\Delta T = 3/2$ and $1/2$ amplitudes. (J.F.P.)

15256 COSMIC-RAY STUDIES OF HIGH-ENERGY STRONG AND WEAK INTERACTION PROCESSES. Naranan, S. (Tata Inst. of Fundamental Research, Bombay). pp 327-34 of Weak Interactions and High-Energy Neutrino Physics. Lee, T. D. (ed.). New York, Academic Press, 1966.

A brief survey is presented of the role played by cosmic-ray investigations in the field of high-energy strong and weak interactions. Mention is made of the effort in Tata Institute, Bombay, which is devoted to a study of the high-energy muons (200 to 2000 GeV) in EAS produced by primary cosmic rays of energy (10^5 to 10^7 GeV). Experiments using cosmic-ray neutrinos and those designed to detect fractionally charged particles in cosmic rays are discussed. (L.B.S.)

15257 ENERGY DEPENDENCE OF THE FORM FACTOR IN $K^0_{\mu 3}$ DECAY. Firestone, A. (Yale Univ., New Haven); Kim, J. K.; Lach, J.; Sandweiss, J.; Taft, H. D.; Guidoni, P. Phys. Rev. Lett., 18: 176-9(Jan. 30, 1967). (BNL-10887).

A sample of 762 decays $K_L \to \pi + e + \nu$ in the 80-inch hydrogen bubble chamber were identified using electron detection by shower production in a tantalum plate. The results are consistent with vector interaction and constant form factor. (auth)

15258 TOTAL MUON-CAPTURE RATE IN ^{3}He FROM CURRENT COMMUTATION RELATIONS. Kim, C. W.; Ram, Michael (Johns Hopkins Univ., Baltimore). Phys. Rev. Lett., 18: 327-30 (Feb. 27, 1967).

The total muon-capture rate in ^{3}He is calculated using the elementary-particle treatment of μ capture in complex nuclei and the current commutation relations introduced by Gell-Mann. The calculation gives Γ_{theor} (^{3}He) = 2020 sec^{-1} to be compared with Γ_{expt} (^{3}He) = 2170^{+110}_{-130} sec^{-1}. (auth)

15259 MEASUREMENT OF THE ABSOLUTE DECAY RATE FOR $K^0_2 \to$ ALL CHARGED 3-BODY MODES. Sciulli, Frank Joseph Jr. Philadelphia, Univ. of Pennsylvania, 1965. 208p.

Thesis.

The absolute decay rate of the long-lived neutral K-meson into 3-body charged modes, Γ_2 (ch), was measured in a spark chamber experiment. Kaons were produced in the reaction $\pi^- + p \to \Lambda^0 + K^0$ with 1 Bev/c pions incident on liquid hydrogen. An anticounter required production of neutrals in the hydrogen, and a counter telescope triggered on the charged secondaries in $\Lambda^0 \to p + \pi^-$. Double vee events were accepted which satisfied the overconstrained production and Λ^0-decay processes, utilizing only the kaon decay vertex. The laboratory decay configuration of the K^0 associated with accepted events was exploited in order to separate about 100 K^0_2 decays to three-body modes and 550 K^0_1 decays ($K^0_1 \to \pi^+ + \pi^-$). The latter events provided the normalization to the K^0_2 charged decay rate. The result was Γ_2 (ch) = $(15.8 \pm 1.9) \times 10^6$ sec^{-1}. Previously measured K^0_2 branching ratios allowed the individual partial rates for all 3-body processes and the total decay rate. Comparison with known K^+ rates proved consistent with the requirements of $|\Delta\vec{I}| = 1/2$ in both nonleptonic and leptonic decays. Quantitative limits were placed on the $|\Delta\vec{I}| \neq 1/2$ amplitudes governing the 3-body K-decays, assuming CP-invariance. (Dissertation Abstr.)

Strong (Baryon-Induced)

15260 MEASUREMENT OF THE SPIN-CORRELATION PARAMETER C_{NN} IN PROTON-PROTON SCATTERING AT 680 MeV. Dost, Helmut E.; Arens, John F.; Betz, Frederick W.; Chamberlain, Owen; Hansroul, Michel J.; Holloway, Leland E.; Schultz,

Claude H.; Shapiro, Gilbert (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 153: 1394-6(Jan. 25, 1967). (UCRL-11877(Rev.)).

Using a polarized beam and polarized target the spin-correlation parameter C_{NN} was measured in proton-proton scattering for an incident-proton laboratory-system kinetic energy of 680 MeV. The polarized beam was made by scattering unpolarized protons from the 184-in. cyclotron in an external first target of liquid hydrogen, resulting in a polarization of 0.44. To reverse the beam polarization, the incident-proton scattering angle was reversed. The target protons were polarized by a solid-state technique called "dynamic polarization" to 0.40 on the average. The elastic proton-proton interactions involving the polarized protons were kinematically separated from other interactions by counting both protons in coincidence. The angular region covered by the 13 data points extends from 51.2 to 88.7 deg in the center-of-mass system. The results show that C_{NN} rises in this region from about 0.5 to 0.9 with a typical standard deviation of 0.1. (auth)

15261 ON THE LOWER LIMIT OF TRANSVERSE MOMENTUM AND FOUR-MOMENTUM TRANSFER OF RECOIL PROTONS IN NUCLEON–NUCLEON INTERACTIONS OF ENERGIES ABOVE 10^{12} eV. Babecki, J. (Inst. of Nuclear Research, Krakow). Acta Phys. Pol., 31: 33-40(Jan. 1967).

The determination of transverse momenta and four-momentum transfers of recoil protons in nucleon-nucleon interactions of ultra-high energy on the basis of kinematical analysis of angular distributions of secondaries in cosmic ray jets is discussed. The method applied consisted in calculating the transverse momentum for all relativistic tracks assuming that the given track is due to a proton and in the selection of the smallest value out of all possible values of $p_\perp$. In spite of this tendency to minimize the transverse momentum a distribution of $p_\perp$ with high mean value of 1.3 GeV/c was obtained. In connection with this also high values of four-momentum transfer were obtained, of the order of a few GeV/c. An analysis of grey and black prongs was also carried out which showed that only very few of them may be tracks of recoil protons. No particular model for multiple production was used; the knowledge of primary energy was also not necessary. (auth)

15262 EXCITED HYPERON OF MASS 1680 MeV. Derrick, M. (Argonne National Lab., Ill.); Fields, T.; Loken, J.; Ammar, R.; Davis, R. E. P.; Kropac, W.; Mott, J.; Schweingruber, F. Phys Rev. Lett., 18: 266-9(Feb. 13, 1967).

Evidence is presented for a new Y_1^* of mass 1680 MeV and width 120 MeV. It is produced in K^-p interactions at 5.5 GeV/c and decays mainly into $\Lambda\pi^+$ and $Y_1^*(1385)\pi$. The decay rate into $\bar{K}^0p$ is 0.3 ± 0.2 of the rate into $\Lambda\pi^+$. (auth)

15263 ANNIHILATION INTO PIONS OF THE $\bar{p}n$ SYSTEM FROM ANTIPROTONS AT REST IN DEUTERIUM. Bettini, A. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua); Cresti, M.; Limentani, S.; (and others). Nuovo Cimento (10), 47A: 642-61(Feb. 1, 1967).

Approximately 20,000 pionic annihilations on neutrons of antiprotons brought to rest in a deuterium bubble chamber were measured and analyzed. 1, 3, and 5-prongs events were studied in detail and the rates into the various multipion final states were determined. Strong production of the pionic resonances ρ, ω, and f^0 was observed, and their production rates are reported. A comparison of some two-body annihilations on protons (in hydrogen) and neutrons (in deuterium) was accomplished finding agreement between the production rates. The ratio of the number of annihilations on the proton and the neutron of the deuterium was determined. (auth)

15264 MEASUREMENT OF THE PROTON–PROTON CROSS SECTION AND POLARIZATION IN THE COULOMB INTERFERENCE REGION AT 213 MeV. Marshall, James Franklin. Rochester, N. Y., Univ. of Rochester, 1966. 114p.

Thesis.

This experiment was a simultaneous measurement of the proton-proton differential cross section and polarization at an incident energy of 213 ± 8 MeV over the angular range 8.9–37.8° cm. In separate runs liquid hydrogen targets of 0.46 and 0.69 gm cm^{-2} were bombarded with a well collimated 90% polarized proton beam and the angular distribution of scattered protons was measured to the right and left of the incident beam line by means of two triple coincidence scintillation telescopes, the defining apertures of which subtended solid angles of 0.00471 and 0.00235 steradians at 30° in the cm system. The counters were mounted on a rotating frame so that they could be shifted frequently from one side of the beam axis to the other during the data runs in order to cancel out instrumental asymmetries. The angular resolution was ±0.6° cm for the first run and ±0.7° cm for the second run. The angular range was chosen to overlap the range of previous measurements at this energy of the relative cross section and polarization which were for cm angles of 30–90°. An absolute normalization of the cross section was obtained to 1.3% accuracy. Important features of this normalization measurement included the use of a fast scintillation telescope to monitor the incident beam and a careful determination of the effective target thickness. An experimental normalization was obtained for the polarization by measuring the left-right asymmetry of p-carbon scattering with the liquid hydrogen target replaced by a carbon target. The data agree well with the predictions of recent phase shift analyses except at angles smaller than 15° cm where somewhat weaker interference effects are indicated by the data. (Dissertation Abstr.)

15265 MEASUREMENT OF THE PROTON–PROTON BREMSSTRAHLUNG CROSS SECTION AT 204 MeV. Rothe, Kenneth Warren. Rochester, N. Y., Univ. of Rochester, 1966. 114p.

Thesis.

A survey experiment to measure cross sections and angular distributions for proton-proton bremsstrahlung at 204 MeV was completed. Spark chambers were used to determine energy and direction of the two outgoing protons. A detector with good angular resolution determined the direction of the gamma rays and set a lower cutoff of 20 MeV on the gamma energy. Three gamma ray angles were investigated ($\theta_{\gamma lab}$ = 90°, 135°, 45°) giving a total of 513 good bremsstrahlung events. Proton center of mass angular distributions indicate the strong presence, in the final two proton system, of angular momentum states with L > 0. In addition, the protons prefer to come off in a plane containing the gamma ray and the incident beam. Proton polarization data agree well in sign with the elastic polarization although the average inelastic polarization is smaller than the elastic value at 210 MeV. The shape of the polarization depends on gamma angle and at $\theta_{\gamma lab}$ = 90° differs significantly in shape from the elastic curve. Gamma asymmetries average -0.146 ± 0.044 (all events included) where the negative sign indicates preference to scatter such that $\bar{P}_{inc} \times \bar{P}_\gamma$ lies antiparallel to the beam polarization and $\bar{P}_{inc}$ is the incident beam momentum. Measured cross sections $(d^2\sigma/d\Omega_\gamma\, dE_\gamma)$ agree in shape with those predicted by Ueda although not in magnitude (the calculations give cross sections ~1.5 times higher than those observed). A comparison with cross sections measured by Gottshalk et al., at 158 MeV indicates that the cross sections are larger than theirs by approximately the factor of three predicted by Duck and Pearce. An invariant mass plot $m_{\gamma,P}$ gives an upper limit for the production cross section of 55 nanobarns for any resonant state $P^* \rightarrow P + \gamma$ in the 950 ≤ mass ≤ 1050 MeV region with lifetimes τ $10^{-22} \leq \tau \leq 10^{-10}$ sec. (Dissertation Abstr.)

Strong (Meson-Induced)

Refer also to abstracts 15254 and 15259.

15266 (CEA-R-3036) CREATION D'UN ET PLUSIEURS MESONS π DANS LES INTERACTIONS π^+p A 1.6 GeV/c. (Single Pion and Several Pions Production in π^+p Interactions at 1.6 GeV/c). Jabiol, Marie-Antoinette (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1966. 75p. (In French). Dep. mn.

Thesis. Submitted to Univ., Paris.

The production of ρ^+, N_{33}^*, and η^0 was observed in π^+p interactions at 1.6 GeV/c. In the reactions where one pion is created, the comparison between the experimental distribution of the ρ^+ and the N_{33}^* with the predictions of the peripheral model modified by absorption effects permits the conclusion that the contribution of this model is important, but that other effects such as interferences between ρ^+ and N_{33}^* are not negligible. In the reactions where several pions are created, the branching ratios of some decay modes of η^0 are evaluated and the associated production of η^0 and N_{33}^* is observed. (auth)

15267 (JINR–E1-3148) OBSERVATION OF THE (e^+e^-) DECAY MODES OF NEUTRAL VECTOR MESONS. Azimov, M. A.; Baldin, A. M.; Belousov, A. S.; (and others) (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1967. 26p. Dep. mn.

The cross sections of (e^+e^-) pair production were measured in the reactions $\pi^- + p \rightarrow V^0 + n$, $V^0 \rightarrow e^+e^-$ at P = 4.0 GeV/c using a system of jointly operating spark chambers and Cherenkov total absorption γ-spectrometers. In contrast to earlier techniques the apparatus made it possible to measure both the opening angles and the energies of the V^0-particle decay products and, hence, to determine its effective mass in each event. There were 13 events detected and identified as the $\rho \rightarrow e^+e^-$ and $\omega \rightarrow e^+e^-$ decays and one $\phi \rightarrow e^+e^-$ event. From the cross sections obtained and total cross sections for ρ, ω, and ϕ mesons known two independent determinations of the width of the vector meson octet decay into e^+ and e^- were made: $\Gamma(V_8 \rightarrow e^+ + e^-) = (0.45 \pm 0.14) \cdot 10^{-4}$ MeV; $\Gamma(V_8 \rightarrow e^+e^-) \leq 2.6 \cdot 10^{-2}$ MeV, which corresponds to probability ratios: $\Gamma(\rho \rightarrow e^+e^-)/\Gamma(\rho) = (0.39 \pm 0.12) \cdot 10^{-4}$; $\Gamma(\omega \rightarrow e^+e^-)/\Gamma(\omega) = (0.48 \pm 0.15) \cdot 10^{-4}$; and $\Gamma(\phi \rightarrow e^+e^-)/\Gamma(\phi) \leq 2.10^{-3}$. The value θ = 38° was used for the $\omega-\phi$ mixing angle. (auth)

15268 REACTION $K^-p \rightarrow K^-p\pi^+\pi^-$ AT 2.0 GeV/c. Dauber, P. M.; Schlein, P. E.; Slater, W. E.; Ticho, H. K. (Univ. of California, Los Angeles). Phys. Rev., 153: 1403-15(Jan. 25, 1967).

An analysis of the reaction $K^-p \rightarrow K^-p\pi^+\pi^-$ at 2.0-GeV/c incident momentum is presented. The total cross section for the reaction is 627 ± 20 μb, based on 4519 events. The reaction is dominated by resonance production through several channels which overlap kinematically but do not appear to interfere substantially. A maximum-likelihood procedure was used to determine the production fractions, which for the major channels are 0.44 ± 0.02 for $N^{*++}(1236)$, 0.145 ± 0.02 for $Y^{*0}(1520)$, 0.10 ± 0.03 for $N^{*+}(1688)$, and 0.20 ± 0.02 for simultaneous $\bar{K}^{*0}N^{*0}$. Evidence is presented for the production of $Y^{*+}(1765)$ and its decay into $Y^{*0}(1520)$ as well as for production of $Y^{*+}(1660)$ with decay into $K^-p\pi^+$. A four-standard-deviation enhancement is present at a $K^-\pi^+$ invariant mass of 690 MeV. Angular correlation data are presented for the $N^{*++}K^-\pi^-$, $Y^{*0}\pi^+\pi^-$, and $\bar{K}^{*0}N^{*0}$ reaction channels. However, the difficulty of separating the various channels prevents a detailed study of the reaction dynamics. (auth)

15269 TWO-CHARGED-PARTICLE FINAL STATES FROM π^- + p INTERACTIONS AT 2.7 GeV/c. Miller, D. H.; Gutay, L.; Johnson, P. B.; Loeffler, F. J.; McIlwain, R. L.; Sprafka, R. J.; Willmann, R. B. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1428. Phys. Rev., 153: 1423-42(Jan. 25, 1967). (COO-1428-19).

A total of 24,360 events having two charged particles in the final state from π^- + p interactions at an incident π^- momentum of 2.7 GeV/c have been analyzed. The final states $\pi^-\pi^+n$ and $\pi^-\pi^0p$ are found to be dominated by rho-meson production, and in addition, significant N*(1238) production is seen. The partial cross sections for the dominant resonant channels are $\sigma = (p\rho^-) = (1.3 \pm 0.2)$ mb, $\sigma(n\rho^0) = (2.3 \pm 0.2)$ mb, and $\sigma[\pi^-N^{*+}(\rightarrow p\pi^0)] = (0.5 \pm 0.2)$ mb. The production of the ρ^- and ρ^0 and the decay of the ρ^- agree very well with the predictions of an absorption modified one-pion-exchange model. The production angular distributions of the ρ^0 and ρ^- follow an exponential of the form Ae^{+Bt}. The results from a least-squares fit give $B(\rho^-) = 9.32 \pm 0.08$ $(GeV/c)^{-2}$, $B(\rho^0) = 10.26 \pm 0.06$ $(GeV/c)^{-2}$. A similar analysis for the elastic-scattering events gave $B(el) = 7.77 \pm 0.05$ $(GeV/c)^{-2}$. The ρ^0 decay distributions are asymmetric and they have been analyzed using a simple model which includes S−P-wave interference. No clear evidence is seen for a T = 0, J = 0 resonance at a mass near that of the ρ. The N*(1238) resonance production is found to be in agreement with the ρ-exchange model of Stodolsky and Sakurai. Indication of other resonance production with small cross section is seen, such as A_1 and A_2 production in the multiple missing neutral events. The masses and widths of the ρ^0 and ρ^- as a function of the four-momentum transfer squared to the nucleon have been determined. (auth)

15270 EVIDENCE FOR AN I = 1 DI-PION RESONANCE AT 1.63 GeV. Crennell, David J. (Brookhaven National Lab., Upton, N. Y.); Hough, Paul V. C.; Kalbfleisch, George R.; (and others). Phys. Rev. Lett., 18: 323-7(Feb. 27, 1967).

A π^-p and a π^+p exposure was made at 6 GeV/c from which 36,000 events were analyzed. The event types analyzed were $\pi^+ + p \rightarrow \pi^+ + \pi^+ + n$, $\pi^- + p \rightarrow \pi^- + \pi^0 + p$, and $\pi^- + p \rightarrow \pi^- + \pi^+ + n$. Dalitz plots and corresponding di-pion mass distributions for the final states are given. Evidence is found for an isospin one (I = 1), positive parity G parity (G = +), negative spatial parity (P = −), and odd spin (J = 3 is favored) ππ at ~1630 MeV. (J.F.P.)

15271 PRODUCTION OF STRANGE PARTICLES FROM π^-p INTERACTIONS AT 2.75 GeV/c. Goussu, O. (CEN, Saclay, France); Smadja, G.; Kayas, G. Nuovo Cimento (10), 47A: 383-99(Feb. 1, 1967). (In French).

Some more results are given on the production of strange particles in π^-p interactions. Besides the partial cross sections of the different processes involved, an attempt is made to derive the density matrix elements of the K* and of the hyperon in $\pi^-p \rightarrow K^*\Lambda$, or $K^*\Sigma$ reactions. In four-body interactions, some indication of excited $K\pi\pi$ and $\Lambda\pi\pi$ states is found. (auth)

15272 CROSS SECTIONS FOR π^-p REACTIONS AT 11 GeV/c AND THEIR t-DEPENDENCE. Caso, C. (Univ., Genoa. Istituto Nazionale di Fisica Nucleare, Genoa); Tomasini, G.; Dittmann, P.; (and others). Nuovo Cimento (10), 47A: 675-9(Feb. 1, 1967).

A sample of 11,357 four-prong events produced in a hydrogen bubble chamber exposed to a negative pion beam of momentum (11.00 ± 0.05) GeV/c was analyzed using standard programs. The production cross sections and their t-dependence for some interactions are discussed. (L.B.S.)

15273 THE η* MESON IN K^--p INTERACTIONS AT 2.23 BeV/c. Goldberg, Marvin. Syracuse, N. Y., Syracuse Univ., 1966. 88p.

Thesis.

The data obtained for this experiment were part of an extensive study of K^-p interactions at 2.23 BeV/c. Approximately 300,000 pictures were taken in an exposure of the 20-inch liquid hydrogen bubble chamber to a separated K^- beam at the A.G.S. Evidence for a neutral meson resonance of mass about 960 MeV/c^2 was found from an effective mass-production angle study of the reaction channels $K^- + p \rightarrow \Lambda$ + neutrals, $K^- + p \rightarrow \Lambda\ \pi^+\pi^-\pi^+\pi^-\pi^0$, $K^- + p \rightarrow \Lambda\ \pi^+\pi^-$ + neutrals. A detailed analysis of these channels and the channel $K^- + p \rightarrow \Lambda\ \pi^+\pi^-\pi^0$ revealed two major η* decay modes: $\eta^* \rightarrow \eta^0\pi\pi/\text{all} = .79 \pm .16$, $\eta^* \rightarrow \rho^0\gamma/\text{all} = .21 \pm .08$. No evidence of any other decay mode was found; upper limits of ~10% were placed on 2π, 3π and 4π modes and rough limits were obtained for rarer modes. From studies of the mass spectrum, the η* mass and width was found to be 958 ± 3 MeV/c^2; $\Gamma < 15$ MeV/c^2, and consistent with zero. An analysis of the branching ratios showed that a second order electromagnetic decay to $\eta^0\pi\pi$ could be ruled out, and therefore $G_{\eta^*} = +1$. Evidence that the isotopic spin I of the η* is zero came from a null result in a search for charged modes, and the $\rho^0\gamma$ decay mode. The latter implies $C_{\eta^*} = +1$ and fixes I = 0 by the relation $G = C(-1)^I$ applied to the $\eta^0\pi\pi$ system. A Dalitz Plot analysis and production-decay angle correlations showed that the η* parity is odd, and spin is probably 0. The possibility that the one-particle-exchange model is involved in $\Lambda\eta^*$ production is considered. The observed forward peaking in production angle and the decay angular distribution are generally consistent with K* exchange (including some absorption). A ($\Lambda\eta^*$) production cross section of 96 ± 18 μb was determined. The relevance of "A" invariance, the σ hypothesis and C, T violation to η* decay was reviewed. It was found that the data require none of these assumptions. (Dissertation Abstr.)

15274 THE φ MESON IN K^--p INTERACTIONS AT 2.23 BeV/c. Lichtman, Stanley. Syracuse, N. Y., Syracuse Univ., 1966. 106p.

Thesis.

From the exposure of a hydrogen bubble chamber to a separated meson (K^-) beam at 2.23 GeV/c evidence was found for the existence of a resonant $K\bar{K}$ system which dominates the $\Lambda K\bar{K}$ and $\Sigma^0K\bar{K}$ final states but does not appear to be produced with Σ^+. On the basis of a test of the isotopic spin triangle inequality it was concluded that the meson (φ) is an isoscalar. Also a $\phi \rightarrow \rho + \pi$ decay mode with a branching ratio $\phi \rightarrow \rho + \pi/\phi \rightarrow K\bar{K} = 0.29^{+0.04}_{-0.11}$ was found. (J.F.P.)

Particle Interactions and Properties (Theoretical)

Refer to abstracts 14943 and 15618.

General

15275 (UR-875-179) REGGE POLE AND GENERALIZED ALGEBRA OF CURRENTS. Okubo, Susumu (Rochester Univ., N. Y. Dept. of Physics and Astronomy). Jan. 4, 1967. Contract AT(30-1)-875. 16p. (CONF-670108-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 4th Conference on Symmetry, Coral Gables, Fla.

By using the generalized algebra of currents defined in the light cone, it is shown that Regge trajectories can be interpreted to correspond to generalized commutators on the light cone. In addition, many sum rules are given. (auth)

15276 SOME NEW TOPOLOGICAL FEATURES OF FEYNMAN GRAPHS. Ramakrishnan, Alladi (MATSCIENCE, Madras). J. Math. Anal. Appl., 17: 68-91(Jan. 1967).

It is shown that if the propagators are decomposed into positive and negative energy arms, a single Feynman diagram splits into 2^{n-1} diagrams called patterns and the correspondence between these patterns and n! terms of field theory can be shown in a manner such as to enhance the topological beauty of a Feynman diagram. Space and time transforms of singular functions, decomposition of the fermion propagators, energy imbalance of a vertex, the composition of imbalances, application to a process of the fifth order, and charge conjugation in Feynman formalism are considered. (J.F.P.)

15277 STRANGE PARTICLES AND DEGENERATE VACUUM. Biritz, H. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nuovo Cimento (10), 47A: 581-8(Feb. 1, 1967).

In the nonlinear spinor theory of Heisenberg and co-workers use is made of a ground state degenerate with respect to isospin. This should imply: (1) due to a somewhat generalized Goldstone theorem the existence of zero-mass bosons connected with this broken symmetry, the photons; (2) the construction of strange particles. This last point is examined in a simple model connected with ferromagnetism. It is shown that there exist Goldstone bosons and bound states of particles which behave as if a

spin (isospin) of the ground state is attached to a particle, thereby forming a "strange" particle. (auth)

15278 VERTEX FUNCTION AND COMPOSITE PARTICLE. Tirapegui, E. (Univ., Paris). Nuovo Cimento (10), 47A: 400-9(Feb. 1, 1967).

It is shown that for a suitable definition of the vertex function of a composite particle in the sense of $Z_3 = 0$ the function satisfies the LSZ theorem. The asymptotic behavior of the form factor in this case is also studied. (auth)

15279 ELEMENTARY PARTICLE THEORIES. Proceedings of the V. Internationale Universitaetswochen fuer Kernphysik 1966 der Karl-Franzens-Universitaet Graz, at Schladming (Steiermark, Austria) 24th February–9th March 1966. Urban, Paul (ed.). Acta Phys. Austr., Suppl. III, 1-463(1966). (CONF-660222).

The conference included 20 papers. Separate abstracts were prepared for each paper. (J.F.P.)

For abstracts of individual papers see: 15280, 15281, 15283, 15325, 15339, 15340, 15363–15372, 15386, 15387, 15400, and 15401.

15280 NONLINEAR SPINOR THEORY OF ELEMENTARY PARTICLES. Duerr, H. P. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Acta Phys. Austr., Suppl. III, 3-41 (1966).

The basic assumptions of the nonlinear spinor theory for elementary particles are given and explained. An unconventional feature of the theory, the assumption of an indefinite metric in Hilbert space, and two group theoretical peculiarities of the theory connected with the assumption of an unsymmetrical vacuum state and the parity problem are discussed. Whereas the indefinite metric appears to be of crucial importance for a consistent dynamical theory, the group theoretical refinements are required to raise the theory to the level of a realistic theory. Also the method for approximate calculation of the masses and coupling constants is indicated. (J.F.P.)

15281 ON SOME APPLICATIONS OF ABSTRACT METHODS IN MATHEMATICAL PHYSICS. (DEFINITION OF A RENORMALIZABLE THEORY AND OF AN UNRENORMALIZABLE THEORY). Destouches, J. L. (Institut Henri Poincare, Paris). Acta Phys. Austr., Suppl. III, 428-39(1966).

Topics considered in the discussion of applications of abstract methods in mathematical physics are the basic differential equation, fundamental theorems, the case of theories with divergences, Sekine's abstract theory of renormalization; also renormalizable and unrenormalizable theories, classification of linear theories, and the case of a theory with several sequences A_μ. (J.F.P.)

Electromagnetic

Refer also to abstracts 15252 and 15308.

15282 (UCRL-16533) MESON-PHOTON CHANNELS AND THE ρ ELECTROMAGNETIC MASS DIFFERENCE. Beder, Douglas S. (California Univ., Berkeley. Lawrence Radiation Lab.). Nov. 22, 1965. Contract W-7405-eng-48. 12p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The effect of coupling between photon-meson channels and strong-interaction channels on the electromagnetic mass-splitting of the ρ-meson multiplet is considered. The result is that no drastic effect occurs, but rather a further small increase in the mass difference of earlier calculations (namely, $M(\rho^0) - M(\rho^+) \approx 13$ MeV). (auth)

15283 RADIATIVE CORRECTIONS IN NUCLEON-β-DECAY AND ELECTROMAGNETIC FORM FACTORS. Kaellen, G. (Univ. of Lund, Sweden). Acta Phys. Austr., Suppl. III, 182-216(1966).

The calculation of the radiative corrections in ordinary β-decay is reviewed with particular emphasis on the modifications necessary because of the fact that the nucleons are not point particles but have a finite extension. The calculations are conveniently performed in a particular gauge where the field operator renormalization constants are all finite (to order e^2). In this gauge one obtains a finite result when one uses a dispersion theoretic approach and neglects all intermediate states with mesons. The result contains the strong interactions only through the conventional nucleon form factors and one new set of form factors which is not experimentally known today. However, in principle they can be observed from independent experiments. (auth)

15284 INELASTIC MODEL OF THE n-p MASS DIFFERENCE. Fried, H. M. (Brown Univ., Providence. Stanford Linear Accelerator Center, Calif.). Contract AT(04-3)-400. Phys. Rev., 153: 1488-9(Jan. 25, 1967). (SLAC-PUB-201).

A simple model of the n-p mass difference is exhibited, in field-theoretic terms, in order to illustrate one way in which the inelastic feedback mechanism may be expected to operate. (auth)

15285 POSSIBLE CHARGE-CONJUGATION NONINVARIANCE IN THE PHOTOPRODUCTION OF NEUTRAL ρ MESONS. Barshay, Saul; Li, Yuan (Rutgers-The State Univ. of New Jersey, New Brunswick). Phys. Rev., 153: 1657-63(Jan. 25, 1967).

The dominant features of the experimental data on the reaction $\gamma + p \rightarrow \rho^0 + p$ which have recently been presented by the Cambridge Electron Accelerator bubble-chamber collaboration are examined theoretically. In accord with the experimentalists' conclusions, it is found that (a) the exchange of a single π^0 does not seem to play an important role in the production mechanism, perhaps merely because of a relatively samll value for the $\rho^0\pi^0\gamma$ vertex; (b) a diffraction production mechanism may play a significant role in the production of ρ^0 at near-forward angles. However, for photon laboratory energies between 1.8 and 6 BeV, about 40% of the ρ^0 are produced at center-of-mass angles θ with $\cos\theta < 0.85$. The question of whether the exchange of a neutral vector meson is considered, in particular the ω^0, can be playing a significant role in the production mechanism; perhaps a dominant role for ρ^0 produced at other than near forward angles. The $\rho^0\omega^0\gamma$ vertex violates charge-conjugation invariance and time-reversal invariance. It is found that the present data on (1) the forward differential cross section as a function of photon energy, (2) the production angular distribution and total cross section at about 5 BeV, and (3) the behavior of the ρ^0 density matrix elements as functions of production angle and photon energy, are completely consistent with the results from the exchange of an ω^0, with a C-violating transition magnetic moment at the $\rho^0\omega^0\gamma$ vertex of the order of unity, in units of $e\hbar/2m_\rho$. It appears that further experiments to elucidate the behavior of the density matrix elements as functions of production angle, in particular at the larger production angles, could detect a variation that is possibly characteristic of the ω^0-exchange mechanism. When the results correspond to some aspect of the data which can also be correlated with diffraction production, it is considered only that the data are consistent with C noninvariance. When the results give rise to some striking aspect which is not an evident feature of diffraction production, it is considered only that C noninvariance provides one possible interpretation should the data exhibit this aspect. In the Appendix, a model is noted in which C noninvariance in the electromagnetic interaction of neutral vector mesons manifests itself in certain processes through C noninvariant and isotopic-spin-violating vertices among hadrons, which are of order α. (auth)

15286 ANALYSIS OF THE REACTION $\gamma + p \rightarrow \eta + p$ NEAR THRESHOLD. Logan, R. K.; Uchiyama-Campbell, F. (Univ. of Illinois, Urbana). Phys. Rev., 153: 1634-5(Jan. 25, 1967).

The enhancement of the $\gamma + p \rightarrow \eta + p$ total cross section near threshold is explained in terms of the S-wave resonance used to fit the similar enhancement of the $\pi + p \rightarrow \eta + n$ cross section. The approximate mass and width of the resonance are 1560 and 150 MeV, respectively. (auth)

15287 DIFFERENTIAL-CROSS-SECTION DIP IN QUANTUM ELECTRODYNAMICS. Henry, G. Reading (Harvard Univ., Cambridge, Mass.). Phys. Rev., 153: 1649-52(Jan. 25, 1967).

In pair production, wide-angle bremsstrahlung, and trident production, a deep, sharp dip is seen in calculated differential cross sections when the sum of outgoing momenta (excluding that of the target nucleus) is collinear with the incident momentum. It is argued that the dip follows very simple from conservation of the electromagnetic current, for all electromagnetic production processes involving spinless bosons, spin-½ fermions, and/or photons. Sufficient conditions for existence of the dip are discussed. (auth)

15288 EXPERIMENTAL LIMIT FOR THE NEUTRON CHARGE. Shull, C. G.; Billman, K. W.; Wedgwood, F. A. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 153: 1415-22 (Jan. 25, 1967).

A microscopic measurement of the charge on a free, monoenergetic neutron has led to the value of $(-1.9 \pm 3.7) \times 10^{-18}$ electron charges. This is consistent with the usual view that neutrons are electrically neutral. The experiment has exploited the very high angular sensitivity of a double-crystal spectrometer in assessing the angular deflection of a monoenergetic neutron beam under electrostatic deflection conditions. An improvement of about six orders of magnitude in the upper limit of the charge over previously published values obtained by direct experimentation has been attained. (auth)

15289 SELF-CONSISTENT BOOTSTRAP MODEL FOR THE ELECTROMAGNETIC MASS SPLITTINGS OF BARYONS AND MESONS. Barton, G. (Univ. of Rochester, N. Y.). Phys. Rev., 153: 1673-7(Jan. 25, 1967). (UR-875-159).

It is assumed that (i) the baryon octet B are bound states of $\underline{B}$ and P, and the pseudoscalar octet P are bound states of B and $\overline{B}$; (ii) magnetic energies and short-range charge-dependent corrections to the strong forces are negligible. Then the only important electromagnetic effects are the Coulomb energies and the mass splittings themselves. The resultant splitting pattern is an intricate function of the F/D ratio; in the currently accepted range of this ratio the pattern agrees with observation as regards signs and orders of magnitude of the mass differences. (auth)

15290 ASSIGNMENT MIXING IN SU(6) AND RADIATIVE MESON DECAYS. Faier, Harry (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 153: 1677-81(Jan. 25, 1967).

It has recently been emphasized by Capps, Belinfante, and Cutkosky (CBC) that under certain conditions the 0^- (P) and 1^- (V) mesons may be classified — in SU(6) — by their total angular momenta rather than their spins. It was noted, however, that this gives rise to an ambiguity in filling the 35-dimensional representation and that, a priori, a linear combination of the available SU(3) multiplets may be considered, the coefficients to be determined by experiment. Here the possibility is explored that the radiative meson decays can help determine some of these coefficients ("assignment mixing" angles). In particular, from an analysis of decays involving the η and X^0 mesons it is concluded that it is consistent to include the pseudoscalar octet and the pseudoscalar singlet in the same 35. Furthermore, the best overall fit to the data is obtained for $\cos\theta_1/\cos\theta_8 \approx 1$, where the cosines represent the respective mixing coefficients for P_1 and P_8. This value has been used by CBC and is also required by $SU(6)_W$. The treatment makes use of the vector pole model to separate the couplings into strong and electromagnetic vertices. (auth)

15291 SCATTERING OF PHOTONS IN A UNIFORM ELECTROMAGNETIC FIELD. Sannikov, S. S. Zh. Eksp. Teor. Fiz., 52: 467-9(Feb. 1967). (In Russian).

Elastic scattering of a photon in a uniform electromagnetic field leading to a change in the photon polarization is considered. An expression for the probability of the process is derived. (auth)

15292 SUM RULES FOR PHOTON–HADRON SCATTERING. Pagels, Heinz (Rockefeller Univ., New York). Phys. Rev. Lett., 18: 316-19(Feb. 27, 1967).

The forward Compton scattering amplitude for photons incident on particles of charge e and mass M is considered. The quark model is used in a purely heuristic way to establish the asymptotic behavior of the forward elastic amplitude for photons incident on hadrons. Sum rules on the total cross sections for photons incident on hadrons are obtained from consideration of target baryon and pseudoscalar octets. Also the amplitude for forward scattering of photons from a target nucleus is discussed. (J.F.P.)

15293 REGGEIZED TADPOLE MODEL AND ELECTROMAGNETIC MASS DIFFERENCES. Okubo, Susumu (Univ. of Rochester, N. Y.). Contract AT(30-1)-875. Phys. Rev. Lett., 18: 256-9(Feb. 13, 1967). (UR-875-177).

The contribution from the high-energy region is considered to be the most important for the electromagnetic mass differences of hadrons. This approach leads to a Reggeized tadpole model. In this way all the mass differences among hadrons, including the fact that a particle in a given isomultiplet with more electric charge has a smaller mass compared to others with less electric charges, can be explained. (J.F.P.)

15294 NEW SUM RULES FOR COMPTON SCATTERING. Harari, Haim (Stanford Univ., Calif.). Phys. Rev. Lett., 18: 319-23(Feb. 27, 1967).

Assuming that all $I = 2$ meson Regge trajectories have $\alpha(0) < 0$, a new set of sum rules for Compton scattering on $I \geq 1$ hadrons are derived. The results are compared with experiment and with other theoretical ideas. (auth)

15295 RADIATIVE CORRECTIONS TO e-p SCATTERING. Bartl, A.; Urban, P. (Univ., Graz). Acta Phys. Austr., 24: 87-95(1966).

Radiative corrections to e-p scattering have been calculated by several authors. The experiments for which these formulas can be used are such that either the scattered electron or the recoil proton are detected with an uncertainty Δp in the momentum, whereas the angle of the detected particle is assumed to be precisely defined. All these calculations are done to the order α^3. Calculation was done for experiments in which the detected particle is allowed to have a spread in angles and in energies. The total contribution of the soft photons which can be summed up to give an exponential is taken into account. The energy of the incident electron is considered to be relativistic and on a sharp value. (W.D.M.)

15296 MESON EXCHANGE CURRENT CONTRIBUTIONS TO THE DEUTERON ELECTROMAGNETIC FORM FACTORS. Casper, Barry Michael. Ithaca, N. Y., Cornell Univ., 1966. 145p. Thesis.

Contributions to the deuteron electromagnetic form factors due to photon interaction with a meson exchange current are investigated. Feynman diagram techniques are employed to analyze the meson exchange graph with a $\rho-\pi$ intermediate state. In this calculation, the four invariant functions characterizing the deuteron-nucleon vertex with one nucleon on the mass shell are related to the nonrelativistic deuteron radial wave functions. The results are corrections to the previously calculated impulse approximation to the deuteron form factors. These corrections are then applied to the analysis of electron-deuteron and electron-proton elastic scattering data in order to obtain the form factors of the neutron. Previous analysis employing the impulse approximation expressions had led to inconsistencies in both G_{En}, the neutron electric form factor, and G_{Mn}, the neutron magnetic form factor. It is found that the meson-exchange corrections are too small to affect significantly the determination of G_{En}. An alternative explanation to the G_{En} discrepancy is suggested. This involves the use of the 4.6% D-state deuteron model recently proposed by Lomon in place of the usual 7% D-state model in the impulse approximation. The effect of the meson-exchange contribution seems to be large enough to account for the inconsistency in the G_{Mn} results. However, a more precise determination of the $\rho-\pi-\gamma$ coupling constant, along with a better understanding of possibly comparable relativistic effects will be required before a definitive judgment can be rendered. (Dissertation Abstr.)

Weak

Refer also to abstracts 15283 and 15383.

15297 STRUCTURE OF $K_{3\pi}$ DECAY. Abarbanel, Henry D. I. (Princeton Univ., N. J.). Phys. Rev., 153: 1547-52(Jan. 25, 1967).

Using the partially conserved axial-vector current and the commutation relations of the vector and axial-vector currents with themselves and with the Hamiltonian responsible for weak nonleptionic decays, it is demonstrated how to expand weak-decay amplitudes in the momenta of pions involved in the decays. The resulting expansion gives the on-mass-shell decay amplitude up to first order in pion momenta. These techniques are applied to the three-pion decays of kaons and it is shown that they quantitatively reproduce the experimental situation of an amplitude linearly dependent on the "odd"-pion kinetic energy. All three pions are treated on an equal footing, and on-the-mass-shell quantities are dealt with everywhere. (auth)

15298 CURRENT ALGEBRA OF SU(6)W AND NONLEPTONIC HYPERON DECAYS. Balachandran, A. P.; Gundzik, M. G.; Pakvasa, S. (Syracuse Univ., N. Y.). Contract AT(30-1)-3399. Phys. Rev., 153: 1553-8(Jan. 25, 1967). (NYO-3399-61).

The parity-violating and parity-conserving parts of the nonleptonic hyperon decay amplitudes are studied in the framework of the group $SU(6)_W$. Describing the decay in terms of the usual weak Hamiltonian H_w bilinear in Cabibo currents by the amplitude $\langle B_2 M|H_w(0)|B_1\rangle$, the meson M is contracted from the final state, the partially conserved axial-vector-current hypothesis is introduced and the meson is taken off the mass shell. The amplitude is then evaluated at an arbitrary point off the mass shell of the meson, assuming the quark model for the currents and a single-particle pole approximation. The nine S-wave and twelve P-wave decays of the baryons in the 56-dimensional representation of $SU(6)_W$ are found to be determined by four parameters, one of which relates the S- and P-wave decays. A new P-wave sum rule for the baryon octet decays $8\sqrt{3}P(\Xi^-) = 3P(\Sigma_0^+) + 3\sqrt{3}P(\Lambda^0) - (5/\sqrt{2})P(\Sigma_2^+)$ is found, as well as new sum rules relating the Ω^- decay to the decays of the baryon octet. With the latter result, the nonleptonic decay rates of the Ω^- are calculated from experimental octet decay amplitudes. (auth)

15299 FADDEEV EQUATIONS FOR THE THREE-PION FINAL-STATE INTERACTION IN τ, τ', AND η DECAYS. Dunn, William A.; Ramachandran, R. (Univ. of California, Riverside). Phys. Rev., 153: 1558-64(Jan. 25, 1967).

The anisotropy in the pion energy spectra for the various three-pion decay modes are assumed capable of providing information concerning the $\pi-\pi$ interaction parameters. Such determinations have so far yielded values that differ radically from those obtained from the analysis of low-energy pion-nucleon elastic scattering as well as production phenomena. The problem is reconsidered in the light of the complete three-body scattering amplitude given according to the prescription of Faddeev. The assumptions made regarding the kernel of the integral equations include (i) a simple off-shell extension of the two-body scattering amplitude, separable in the initial and final momenta, (ii) a nonrelativistic framework except for the pion kinematics, and (iii) an attractive s-wave $\pi-\pi$ interaction in the absence of bound states or resonances. Besides the pion scattering-length parameters, a momentum cutoff exists

which, over a wide range of values, has an insignificant effect on the shape of the pion energy spectrum. The integral equations are solved numerically and the parameters that best fit the pion spectra for τ, τ', and η decay are obtained. In each case the s-wave scattering length a_2 is found to be much larger than a_0. This confirms the conjecture that the inclusion of the three-particle effects does not significantly alter the general features of earlier work. (auth)

15300 STRANGENESS-CHANGING DECAY PROCESSES. Tanaka, K. (Ohio State Univ., Colombus). Phys. Rev., 153: 1519-22(Jan. 25, 1967). (COO-1545-11).

The effective coupling constant $G(\sin\theta \sin\delta)/\sqrt{2}$ of $\Delta S = 1$, $\Delta Q = 0$ processes and $G(\sin\theta \cos\delta)/\sqrt{2}$ of $\Delta S = \Delta Q = 1$ processes is studied on the basis of the decay rates of the leptonic and photonic decay modes of hadrons, where S is the strangeness quantum number, Q is the charge, and θ is the Cabibbo angle. The decay rates give information on $\sin\delta$ together with arbitrary mass factors. When the mass factors are eliminated, one finds both for the vector current and the axial-vector current a very small angle δ, which expresses a drastic reduction of the $\Delta S = 1$, $\Delta Q = 0$ processes. The decay modes connected with the weak vertex ($\Sigma^- \rightarrow n$); $\Sigma^- \rightarrow n + \pi^-$, $\Sigma^- \rightarrow n + e^- + \bar{\nu}$, and $\Sigma^- \rightarrow n + \pi^- + \gamma$, are examined together and it is found that the vector-current dominance of $\Sigma^- \rightarrow n + e^- + \bar{\nu}$ decay is consistent with the S-wave decay of $\Sigma^- \rightarrow n + \pi^-$ and parity-conserving decay of $\Sigma^+ \rightarrow p + \gamma$. The decay rate of $\Sigma^- \rightarrow n + \pi^- + \gamma$ is estimated and found to be in agreement with a previous estimate and experiments. (auth)

15301 TWO NEUTRINOS OR ONE? Shishkin, G. V. (Inst. of Nuclear Power Engineering, Academy of Sciences, Belorussian SSR). Dokl. Akad. Nauk BSSR, 10: 381-4(June 1966). (In Russian).

Cross sections of weak four-fermion interactions were analyzed in order to find the possibility of experimental verification of the component nature of the neutrino (two component neutrino or one four-component neutrino). All weak four-neutrino interactions were separated into three groups: the β-decay process with neutron and strange particle [electron neutrino (antineutrino)]; muon decay of strange particles (muon neutrino), and negative and positive muon decay (processes with simultaneous participation of electron and muon neutrino). (R.V.J.)

15302 CALCULATION OF THE K_1 AND K_2 MASS DIFFERENCE. Vainshtein, A. I.; Khriplovich, I. B. (Novosibirsk State Univ., USSR). JETP Lett. (USSR) (Engl. Transl.), 5: 57-9(Jan. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 70-3(Jan. 15, 1967).

The connection between the matrix elements of the $K \rightarrow \pi$ and $K \rightarrow 2\pi$ transitions are obtained so that the contribution of the meson (π) pole diagram to the mass difference of K_1 and K_2 can be calculated. When added to the contribution of the meson (η) state (the $K \rightarrow \pi$ and $K \rightarrow \eta$ decays are related with the aid of SU(3)), this leads to $\Delta m \equiv m_1 - m_2 = 0.75\ \Gamma_1$. (J.F.P.)

15303 CURRENT ALGEBRA AND $\eta \rightarrow \pi^+\pi^-\pi^0$ SPECTRUM. Ramachandran, R. (Univ. of California, Riverside). Nuovo Cimento (10), 47A: 669-72(Feb. 1, 1967).

The methods of current algebra and PCAC are used to estimate the slope of the π^0 spectrum of $\eta \rightarrow \pi^+\pi^-\pi^0$ decay. The lack of close agreement for the magnitude of the slope with the experimental number is possibly due to the fact that $\eta \rightarrow \pi^+\pi^-\pi^0$ has a sizable I = 3 admixture. Further evidence is found for the I = 3 state in that the experimental branching ratio $(\eta \rightarrow \pi^0\pi^0\pi^0)/(\eta \rightarrow \pi^+\pi^-\pi^0) = 0.8$ is in disagreement with the I = 1 prediction of 1.5. The treatment thus is regarded as giving the contribution of the I = 1 state to the π^0 energy spectrum. (L.B.S.)

15304 WEAK INTERACTIONS AND HIGH-ENERGY NEUTRINO PHYSICS. Course XXXII of Proceedings of the International School of Physics "Enrico Fermi," Varenna, Italy, June 15-27, 1964. Lee, T. D. (ed.). New York, Academic Press, 1966. 344p. $16.00.

Separate abstracts are prepared for each of the 13 lectures presented. (L.B.S.)

For abstracts of individual lectures see: 15256, 15305-15315, and 15378.

15305 WEAK INTERACTIONS. Bernardini, G. (Scuola Normale Superiore, Pisa, Italy). pp 1-51 of Weak Interactions and High-Energy Neutrino Physics. Lee, T. D. (ed.). New York, Academic Press, 1966.

Lectures are presented in three parts on weak interactions. Part I gives a review of the history of neutrino physics. The most fundamental achievements in this field are discussed: the neutrino hypothesis by Pauli in 1931; the Fermi theory in 1934: the discovery of the weak behavior on the meson and the formulation of the Universal Fermi Interaction; the first neutrino experiment by Reines and Cowans in 1956; the discovery that the neutrino interactions violate parity; the two-component neutrino theory; the V-A formulation of the Universal Fermi Interaction in three independent but equivalent ways; the old idea of the existence of two independent neutrinos, put forward again by Nishijima in 1957, and the suggestion of using high-energy accelerators in order to extend to high momenta the neutrino physics; and the experimental evidence that two neutrinos exist. Part II discusses the one- or two-neutrinos question and other general facts concerning the high-energy interactions of neutrinos. Part III treats the lower limit of the mass of the weak-interactions' intermediate boson, with discussions on some basic properties of intermediate bosons, high-energy neutrino boson production, search for leptonic decays, and bubble chamber results of nonleptonic decays. (L.B.S.)

15306 BETA DECAY. Wu, C. S. (Columbia Univ., New York). pp 52-95 of Weak Interactions and High-Energy Neutrino Physics. Lee, T. D. (ed.). New York, Academic Press, 1966.

An attempt is made to present an integrated picture of beta decay, starting from the fundamental assumptions postulated in Fermi's theory of beta decay, and gradually leading to its general formulation. By comparing with experimental evidences, it is shown how the coupling constants involved in the beta interaction are uniquely determined. Furthermore, it is illustrated how the symmetry properties of beta interactions and the nature of the neutrino are investigated through the so-called "parity experiments." Finally a review is given on the question of universal Fermi (V-A) interaction and the conserved vector current theory. No detailed derivations for the theoretical formulas used are given, however, a detailed bibliography is provided for this purpose. (L.B.S.)

15307 THEORETICAL SURVEY ON MUON PHYSICS. Primakoff, H. (Univ. of Pennsylvania, Philadelphia). pp 96-121 of Weak Interactions and High-Energy Neutrino Physics. Lee, T. D. (ed.). New York, Academic Press, 1966.

The basic reasons for the special interest in the muon are enumerated, followed by a brief discussion of the physical parameters of the isolated muon in slowly varying (classical) gravitational and electromagnetic fields. A survey of the weak interactions of the muon is then presented; the topics covered include muon decay, generalities of muon capture, and results of application of the general theory to muon capture in hydrogen and helium and the comparison of these results with experiment. (L.B.S.)

15308 MUON PHYSICS. Lederman, L. M. (Columbia Univ., New York). pp 122-41 of Weak Interactions and High-Energy Neutrino Physics. Lee, T. D. (ed.). New York, Academic Press, 1966.

Experimental data which lend support to the V theory (universal Fermi interaction with V-A and CVC) are surveyed. Lectures are given on weak interaction properties of the μ-meson, including muon decay, muon capture, and experiments bearing on G_p (induced pseudoscalar), and also on the electromagnetic properties—the g - 2 experiment, μ-pairs experiment, and μ-p scattering. (L.B.S.)

15309 THEORETICAL SURVEY OF HIGH-ENERGY NEUTRINO INTERACTIONS. Lee, T. D. (Columbia Univ., New York). pp 142-60 of Weak Interactions and High-Energy Neutrino Physics. Lee, T. D. (ed.). New York, Academic Press, 1966.

The present status of weak interactions is briefly reviewed. Other topics include elastic and inelastic cross sections for high-energy neutrino reactions with production of intermediate bosons, basic properties of intermediate bosons, consequences of $|\Delta T| = \frac{1}{2}$ and $|\Delta S| \neq 2$ rules, and the production of W. (L.B.S.)

15310 NEUTRINO EXPERIMENTS. Schwartz, M. (Columbia Univ., New York). pp 161-75 of Weak Interactions and High-Energy Neutrino Physics. Lee, T. D. (ed.). New York, Academic Press, 1966.

A review is given of the first high-energy neutrino experiment performed at Brookhaven AGS in order to show how the nonidentity of the electron neutrino and the muon neutrino was first demonstrated. An attempt is then made to point out the limitations of the current series of neutrino experiments, both at CERN and Brookhaven, and show how many of these limitations will be removed with the advent of new accelerators and detectors. (L.B.S.)

15311 PRESENT NEUTRINO EXPERIMENTS. Lederman, L. M. (Columbia Univ., New York). pp 176-86 of Weak Interactions and High-Energy Neutrino Physics. Lee, T. D. (ed.). New York, Academic Press, 1966.

A general introduction is given to the neutrino experiments carried out at CERN and BNL. Descriptions are given of the arrangement of the major elements: primary proton beam,

focusing, shielding, detectors, calibration, and neutrino flux. (L.B.S.)

15312 $\mathcal{N}^*$ PRODUCTION BY NEUTRINOS. Veltman, M. (CERN, Geneva). pp 187-205 of Weak Interactions and High-Energy Neutrino Physics. Lee, T. D. (ed.). New York, Academic Press, 1966.

The production of N* pion-nucleon resonance by neutrinos and antineutrinos is treated. The spin-$\frac{3}{2}$ particle formalism is first reviewed. The form is then given of the hadron current in the process $\nu + N \rightarrow \mu + N^*$, which can be obtained under several general assumptions, as well as branching ratios, obtained from the isospin behavior of this expression. The influence of time-reversal invariance on the process $\nu + N \rightarrow \mu + N^*$ is investigated. The $\bar{\nu} + N \rightarrow N^* + \mu$ process is discussed, which is related to $\nu + N \rightarrow N^* + \mu$ if hadron currents are believed to be of the first kind. It is noted that in the framework of SU(3) there is a very tight connection between the coupling of the recently discovered Ω^- to leptons and the N* production by ν and $\bar{\nu}$. This is also discussed in relation to its direct connection, in principle, with the rates for N* production. (L.B.S.)

15313 PROPERTIES OF THE WEAK INTERACTIONS. Dalitz, R. H. (Oxford Univ.). pp 206-70 of Weak Interactions and High-Energy Neutrino Physics. Lee, T. D. (ed.). New York, Academic Press, 1966.

Lectures are presented on the properties of weak interactions, with emphasis on the experimental situations providing evidence for the conservation laws and symmetry principles which appear likely to hold for the weak interactions, and on the predictions and implications of these principles, especially in their possible relation with unitary symmetry. The current-current hypothesis introduced by Feynman and Gell-Mann is assumed as a general framework. The lectures cover strangeness-conserving leptonic decay interactions, strangeness-changing leptonic decay processes, and nonleptonic decay processes. CP violation in weak interactions is discussed in the appendix. (L.B.S.)

15314 EXPERIMENTAL SURVEY OF STRANGE-PARTICLE DECAYS. Steinberger, J. (Columbia Univ., New York). pp 271-98 of Weak Interactions and High-Energy Neutrino Physics. Lee, T. D. (ed.). New York, Academic Press, 1966.

The present experimental knowledge concerning the decays of the strange particles is summarized. Lifetimes and branching ratios of the K mesons and of the hyperons are tabulated. In conclusion, the following points are made: 1) The $\Delta T = \frac{1}{2}$ rule has been checked in the case of the decays $\Lambda \rightarrow \pi + N$, $\Sigma \rightarrow \pi + N$, $K \rightarrow \pi + \pi$, $K \rightarrow \pi + \pi + \pi$, $K \rightarrow l + \nu + \pi$, and is in good agreement both in the case of leptonic and nonleptonic decay, with the exception of a violation in amplitude of approximately 5% in the $K \rightarrow 2\pi$ decay. 2) The $\Delta S = \Delta Q$ rule is at least approximately valid. It is checked in the decays $K_2 \rightarrow l + \pi + \nu$, $\Sigma \rightarrow l + \pi + \nu$, and $K \rightarrow 2\pi + e + \nu$, and the violating amplitudes are at most of the order of 20%. 3) The strangeness change is at most 1. $|\Delta S| \leq 1$. 4) The lepton current for all leptonic decays is compatible with the form $\bar{\mu}_2\gamma(1 + \gamma_5)u_\nu + c.c.$ 5) The Cabibbo scheme based on SU(3) shows promise of being able to relate the various leptonic decay processes of strongly interacting particles. (L.B.S.)

15315 WEAK INTERACTIONS AND THE UNITARY SYMMETRY. Cabibbo, N. (CERN, Geneva). pp 299-310 of Weak Interactions and High-Energy Neutrino Physics. Lee, T. D. (ed.). New York, Academic Press, 1966.

An account is given of recent progress in the understanding of weak interactions which followed the discovery of the approximate unitary symmetry of strong interactions. The following subjects are covered: universality of weak interactions; the angle θ in a simplified model; and leptonic interactions in the limit of exact SU(3) (hyperon decays). (L.B.S.)

15316 LEPTONS, A MEDIUM FOR ENERGY TRANSMISSION. Dudley, H. C. (Univ. of Southern Mississippi, Hattiesburg). 14p. (CONF-651213-16). DTIE, Gmelin, AED-CONF-65-400-37.

From American Physical Society, Winter Meeting in the West, Los Angeles.

Leptons are defined as a family of particles having finite mass less than 210 m_e, and include the neutrino-antineutrino group. Neutrinos of mass of the order 2×10^{-3} m_e exist as a generalized flux 7×10^{10} $\eta/cm^2/sec$, their source being stellar and interstellar nuclear processes. Recent astrophysical observations indicate our solar system consists of interlocking gravitational, electric, and magnetic fields, and our sun to be a negatively charged body generating an electric field such that the earth's orbit is at a potential of 3×10^{17} volts (+) with respect to the sun. Under these conditions a flux of uncharged magnetic dipoles in random motion (i.e. neutrinos) would provide a medium for transmitting the energy of a charged oscillator, i.e. an electromagnetic wave. The wave velocity would not be a constant, but a function of flux concentration, electric and magnetic field strengths. The pathway of light in space would not necessarily be linear, nor on a Riemannian curve, as electromagnetic radiation would be refracted by variations of flux concentration or changes in any field gradient. These hypotheses will be strengthened or rendered untenable as additional subnuclear and astrophysical data become available. (auth)

Strong (General)

Refer also to abstracts 15256 and 15351.

15317 BOUND STATES OF A RELATIVISTIC TWO-BODY HAMILTONIAN; COMPARISON WITH THE BETHE-SALPETER EQUATION. Son, Nguyen D.; Sucher, J. (Univ. of Maryland, College Park). Phys. Rev., 153: 1496-1501(Jan. 25, 1967).

The tightly bound states of a simple relativistic two-body Hamiltonian are studied. The coupling constant necessary for obtaining a given binding energy is obtained numerically for a Yukawa-like interaction with variable range. Some fairly general relations restricting the connection between binding energy, coupling constant, and force range, expected to be valid in the tight-binding limit, are derived and tested. A comparison is made with results obtained by Schwartz for the "corresponding" Bethe-Salpeter (B-S) equation. It is concluded that, even in the strong-binding limit, the pair, multimeson, and retardation effects taken into account by the ladder-approximation B-S equation are not very important, at least as far as the relation between coupling constant and binding energy is concerned. These results suggest that a Hamiltonian of the type considered may be a useful tool in exploratory calculations involving quark models. In this connection, it is shown that a Yukawa-like interaction leads to relativistic motion in the tight-binding limit even if used in a Hamiltonian incorporating relativistic kinematics, and thereby a result of Greenberg's is generalized. (auth)

15318 QUARK DECOMPOSITION OF HADRON SCATTERING AMPLITUDES. James, P. B.; Watson, H. D. D. (Univ. of Illinois, Urbana). Contracts NSF GP-5622; 00014-66-C00010-A05. Phys. Rev. Lett., 18: 179-82(Jan. 30, 1967).

It is shown how the discrepancy between sum rules relating meson–baryon to baryon–baryon total cross sections and experiment can be removed with careful formulation and application of the additivity postulate for the quark–quark scattering amplitudes. The kinematical conditions under which sum rules are to be compared with experiment are discussed and are specialized to the case of π or N scattering off a nucleon target. (L.B.S.)

15319 NUCLEON FORM FACTORS AND UNIVERSAL VECTOR COUPLING. Signell, Peter; Durso, J. W. (Michigan State Univ., East Lansing). Phys. Rev. Lett., 18: 185-8(Jan. 30, 1967).

Assuming various combinations of nucleon (N), $\Delta(1236)$ (N^*), and ρ as dominant participants in the low-energy isovector $\pi + \pi \rightarrow N + N$ amplitude, the nucleon isovector form factors were calculated for moderate momentum transfer. The calculation was made in order to determine the effect of the use of N and N* and a finite-width ρ on the theoretical parameters and on the fit of various models to the data, and to produce a form-factor-predicted ρNN vector coupling constant for another test of the hypothesis of universal vector coupling. (L.B.S.)

15320 DYNAMICAL APPROACH TO CURRENT ALGEBRA. Weinberg, Steven (Univ. of California, Berkeley). Phys. Rev. Lett., 18: 188-91(Jan. 30, 1967).

An effective Lagrangian for soft-pion interactions is constructed such that lowest order perturbation theory precisely reproduces the results of current algebra. (auth)

15321 QUARKS AND SPINNING TOPS. Corben, H. C. (TRW Systems, Redondo Beach, Calif.). Nuovo Cimento (10), 47A: 482-94(Feb. 1, 1967).

The classification of baryon and meson states provided by the quark model is compared with that offered by the spinning-top model, in which the spin is the sum of three vectors the lengths of which determine the strangeness, isospin, baryon parity, and meson G-parity. For the lower lying baryon states and many of the meson states the two models are similar, being in fact identical for a baryon decimet and for the 1^- octet. Classification of all strongly interacting states known at present is shown to be possible without being led to expect the existence of quarks. The models differ, however, with respect to the states which they predict, an Ω of $J = \frac{1}{2}$, $I = 0$ being impossible to form in the spinning top model, whereas states with higher values of isospin appear without modifying this model in any way. (auth)

15322 STRONG INTERACTIONS. Course XXXIII of Proceedings of the International School of Physics "Enrico Fermi," Varenna, Italy, July 6–18, 1964. Alvarez, L. W. (ed.). New York, Academic Press, 1966. 235p. $11.50.

This book contains discussions of the experimental facts concerning meson and baryon resonances. The presentation is directed toward the elucidation of theories that will explain the presently known phenomena which could be subjected to experimental tests in the near future. Separate abstracts are prepared for each of the four lectures included. (L.B.S.)

For abstracts of individual sections see: 15323, 15324, 15338, and 15385.

15323 PRODUCTION AND DECAY OF RESONANT STATES. Dalitz, R. H. (Oxford Univ.). pp 141-88 of Strong Interactions. Alvarez, L. W. (ed.). New York, Academic Press, 1966.

Lectures are presented concerning the resonance production processes of the type $a + b \rightarrow c + d^*$, followed by two-body decay of the resonance d^*, $d^* \rightarrow e + f$. The overall process is considered in these two stages in terms of the spin density matrix resulting for d^* from the production process, and the properties of the decay process for given spin density matrix for d^*. The decay of boson resonances is discussed, considering only decay to two pseudoscalar mesons, for the following cases: pseudoscalar-meson exchange, vector-meson exchange, axial vector-meson exchange, and spin 2^+ exchange. The Byers-Fenster method is then discussed for the spin-parity determination of baryonic states, considering the two-body decay leading to a baryon and a pseudoscalar meson. 56 references. (L.B.S.)

Strong (Baryon No. = 0)

15324 MESON RESONANCES. Miller, D. H. (Univ. of California, Berkeley). pp 1-69 of Strong Interactions. Alvarez, L. W. (ed.). New York, Academic Press, 1966.

The phenomenological description of meson states and the general methods used for determination of their quantum numbers are discussed. The analysis is applied in a variety of experimental situations; in particular, to the discovery and elucidation of the properties of the well-established nonets of pseudoscalar and vector mesons. In addition, the properties of a probable nonet of $J^P = 2^+$ mesons are discussed. The recent experimental observations of enhancements in several new systems are also reviewed. 90 references. (L.B.S.)

15325 TRIPLET MODEL OF ELEMENTARY PARTICLES. Thirring, W. (Univ., Vienna). Acta Phys. Austr., Suppl. III, 294-315(1966).

The model of a fundamental triplet of fractionally charged fermions (quarks) is reviewed. Strong, electromagnetic, and weak interactions are considered. Also higher resonances, forces between quarks, and the 3-quark states are discussed. (J.F.P.)

15326 DETERMINATION OF S-WAVE PION–PION SCATTERING LENGTHS. Meiere, F. T.; Sugawara, Masao (Purdue Univ., Lafayette, Ind.). Phys. Rev., 153: 1702-9(Jan. 25, 1967).

The S-wave pion-pion scattering lengths a_0 and a_2 in the channels of total isospin 0 and 2, respectively, are determined by requiring that the high-energy limit of the pion-pion total cross section be the same in all isospin channels. The determination consists of using the once-subtracted dispersion relation and the phase representation which are satisfied by the crossing-symmetric forward pion-pion amplitudes and also the unsubtracted dispersion relation valid for the crossing-antisymmetric amplitude. The specific approximations to be made are that the scattering becomes asymptotic fairly rapidly above the p and f resonances in respective channels, that these are the only $\pi\pi$ resonances in the energy region up to the f resonance, that the S wave dominates below the resonances, and that the conventional effective-range expansion is valid for the S wave with the effective range between zero and $2\mu^{-1}$ (where μ^{-1} is the pion Compton wavelength and the pion-pion force range is expected to be $0.5\mu^{-1}$ because of 2-pion exchange). The scattering lengths are determined as $\mu a_0 = 0.25 \pm 0.08$ and $\mu a_2 = 0.0 \pm 0.03$. The uncertainties are based upon the variations in a_0 and a_2 due to changes in the parametrization of the $\pi\pi$ scattering used in the present determination. It is found that the unknown details of high-energy scattering are relatively unimportant in this determination of a_0 and a_2. It is shown that the above values of a_0 and a_2 are consistent with the partially conserved axial-vector current sum rule due to Adler. This is contrary to the conclusion of previous authors; the difference is attributed to a different use of the sum rule. When one of the conjectured resonances (σ and ϵ) is added as a true resonance, no solution is found to make the high-energy limit of the total cross section the same with the parametrization of the phase and the cross section considered in the present work. (auth)

15327 OFF-THE-MASS-SHELL CORRECTION IN PION–PION SCATTERING. Meiere, F. T.; Sugawara, Masao (Purdue Univ., Lafayette, Ind.). Phys. Rev., 153: 1709-12(Jan. 25, 1967).

A discussion is given of the off-the-mass-shell correction to the PCAC (partially conserved axial-vector current) relation for pion-pion scattering. In particular, special attention is drawn to the fact that the usual s and u cuts of the pion-pion amplitude give rise to cuts in the external pion mass extended far below the cut due to the three-pion intermediate state. An estimate is made of the off-the-mass-shell correction due to these induced cuts. It is shown that this correction is not likely to be significant as long as the S-wave pion-pion interaction is relatively weak, implying that the use of the PCAC relation for pion-pion scattering without the off-the-mass-shell correction is not expected to be any worse than that for any other PCAC relation. (auth)

15328 UNIVERSALITY PRINCIPLES WITH 1^- AND 2^+ DOMINANCE. Patil, Sharashchandra H.; Yao, York-peng (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 153: 1455-8 (Jan. 25, 1967).

It is assumed that the photon and graviton form factors are dominated by the vector and tensor mesons, which leads to the result that the vector- and tensor-meson couplings are renormalized in the lowest order of the SU(3)-symmetry-breaking interaction, but in a definite way. This result is different from the one obtained by Gatto and Ademollo, where vector currents are unrenormalized. The consequences of this assumption for the weak interaction, universality of meson couplings, and meson-baryon cross sections are discussed. The results are compared with experimental widths, and the agreement is found to be good. (auth)

15329 STUDY OF MULTICHANNEL DYNAMICS IN THE NEW STRIP APPROXIMATION. Bali, N. F.; Chu, Shu-yuan (Univ. of California, Berkeley). Phys. Rev., 153: 1579-91(Jan. 25, 1967). (UCRL-16874(Rev.)).

A systematic study of the dynamics of scattering with several coupled two-particle channels is made using the new strip approximation. The existence of a unique solution to the ND^{-1} equations is established from maximal analyticity of the second degree. The method used is an extension of Jones's proof in the single-channel case, making use of an explicit expression for the determinant of D constructed by Gross. The general method is then applied to the particular case of a $\pi\pi$-$K\overline{K}$ two-channel calculation of the ρ meson, first with fixed-spin particle and then with Reggeized particle exchange as the generalized potential. A detailed discussion of the numerical result is presented, with the conclusion that the effect of the inelastic channel ($K\overline{K}$) is not important in the present approximation scheme. (auth)

15330 NEW CONSISTENCY CONDITIONS ON PION–PION AMPLITUDES AND THEIR DETERMINATION TO FOURTH ORDER IN EXTERNAL MOMENTA. Khuri, N. N. (Stanford Linear Accelerator Center, Calif. Rockefeller Univ., New York). Contract AT(04-3)-400. Phys. Rev., 153: 1477-85(Jan. 25, 1967). (SLAC-PUB-209).

A set of new consistency conditions for the pion-pion scattering amplitude is derived. These conditions hold for any s, t, u in the cube $0 \leq s, t, u \leq \mu^2$, with the four external mass variables off the mass shell and restricted so that $q_1^2 = 0$, $q_2^2 = s$, $q_3^2 = t$, and $q_4^2 = u$. Using these consistency conditions, the coefficients of the power-series expansion of the pion-pion amplitude are determined up to and including second-order terms in the variables s, t, u, and q^2. This expansion is used to calculate the pion-pion S-wave scattering lengths and thus check the consistency of Weinberg's recent calculation of these numbers to the next higher order. The final result is within 10% of that obtained by Weinberg. (auth)

15331 SUM RULE FOR π^0, η, AND X^0 MESON INTERACTION CONSTANTS. Fainberg, V. Ya.; Fil'kov, L. V. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 5: 51-3(Jan. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 64-7(Jan. 15, 1967).

A consistent application of the principle of minimal singularity of interaction to scattering amplitudes makes it possible to establish the required number of subtractions in the dispersion integrals for invariant amplitudes. It can be shown in particular that out of the six invariant amplitudes T_i (s,t) (i = 1, 2, . . . , 6), in terms of which the total γN scattering amplitude is expanded, T_2, T_4, and T_6 satisfy subtractionless dispersion relations in the s channel, while the amplitude T_5 approaches a constant limit asymptotically (as $s \rightarrow \infty$). A sum rule for the amplitude T_5 is derived, and it is attempted to relate it to the constants of the mesons (π^0), (η), and (X^0). (J.F.P.)

15332 HEAVY PARTICLE PAIR PRODUCTION. Sisakyan, I. N.; Feinberg, E. L.; Chernavskii, D. S. Zh. Eksp. Teor. Fiz., 52: 545-56(Feb. 1967). (In Russian).

An important result obtained in recent years is discovering that such high-energy hadron-interaction processes exist which pass

through the compound state ("head-on collisions"). Such processes do not only determine binary scattering $A + B \rightarrow C + D$ involving a large 4-momentum transfer $\sqrt{-t} > 1$ GeV, but as shown, $p\bar{p}$ and $d\bar{d}$ heavy pair production also. In this case one may differentiate between pair production in NN collisions involving the formation of other particles, such as pions, and processes of the type $A + \bar{A} \rightarrow B + \bar{B}$ which do not involve other particles. An example of the latter case is heavy pair production by γ-quanta when the form factor F of the $\gamma\bar{p}p$ vertex is determined by formation of the compound state. Application to the cross section σ_q for $q\bar{q}$ quark pair production in NN and $N\bar{N}$-collisions shows that if the quarks interact with hadrons at distances $m_{\bar{N}}^{-1} \sim \mu^{-1}$ as strongly as the hadrons interact between themselves, then σ_q should be extremely small and decrease exponentially with the mass m_q. If, however, the interaction is weaker σ_q may be large and approach the geometric cross section. This result is practically true for any type of generation mechanism. The same reasoning is employed for estimating the time-like form factor for the $\gamma p\bar{p}$ vertex. The result is compared with the experiments on $p\bar{p} \rightarrow e^- e^+(\mu^- \mu^+)$ annihilation. (auth)

15333 B MESON AND THE DECAY $\rho \rightarrow \pi^+\omega$. Parkinson, Michael (Univ. of California, Los Angeles). Phys. Rev. Lett., 18: 270-2(Feb. 13, 1967).

A kinematic effect leading to a $\pi\omega$ bump around 1220 MeV is presented for the decay $\rho \rightarrow \pi + \omega$. The starting point for the analysis presented is a relativistic analytic generalization of the Breit–Wigner resonance formula, which was derived from two different points of view, N/D effective range theory and K matrix theory. (J.F.P.)

15334 BOUNDARY CONDITION MODEL APPLIED TO ANTI-HYPERON–NUCLEON SCATTERING. II. Spergel, M. S. (Univ. of Rochester, N. Y.). Nuovo Cimento (10), 47A: 439-50(Feb. 1, 1967).

The differential elastic cross sections, total elastic, charge-exchange and annihilation cross sections, and polarization were calculated up to several hundred MeV for antihyperon–nucleon scattering. Cross sections were also calculated for $\bar{\Lambda}\Lambda \rightarrow \bar{\Sigma}\Lambda$. The model employed for the calculation utilizes an "elastic" one- and two-pion potential plus an absorptive-core boundary condition. The "elastic" antihyperon-nucleon potential is constructed using SU_3 group symmetries. (auth)

15335 BOUNDARY CONDITION MODEL APPLIED TO ANTI-NUCLEON–NUCLEON SCATTERING. I. Spergel, M. S. (Univ. of Rochester, N. Y. Grumman Research Center, Bethpage, N. Y.). Nuovo Cimento (10), 47A: 410-38(Feb. 1, 1967).

An improved boundary condition plus elastic potential was developed for calculating the elastic, charge exchange and annihilation cross sections for the antinucleon-nucleon system in the nonrelativistic energy region (50 to 300 MeV in the laboratory system). The boundary condition is taken to maximize the absorption cross-section in each channel of specified isotopic spin, ordinary spin, and total angular momentum. The elastic potential is constructed by modifying the one-pion and two-pion nucleon-nucleon potentials in the usual manner. The results fit the available data reasonably well for both the differential elastic cross section and the total annihilation cross section, using a single core, however best fit is obtained separately when one chooses to fit the annihilation to a larger core than the elastic cross section. Charge-exchange scattering is found to be quite sensitive to the size of the core region. (auth)

15336 EFFECTIVE NONLOCAL POTENTIAL AT SMALL DISTANCES. Balazs, L. A. P. (Univ. of California, Los Angeles). Nuovo Cimento (10), 47A: 470-81(Feb. 1, 1967).

In making dynamical calculations with the Blankenbecler–Sugar equation (which is actually just a way of rewriting the Schroedinger equation with a specific type of nonlocal energy-independent potential), one generally approximates the potential with one-particle exchange diagrams. In the present approach, the potential is, instead, constructed so as to give exactly the imaginary parts of the low partial waves in the crossed channel; these serve as the inputs in the calculation. It can then be argued that repulsive contributions should appear at small distances, making it possible to obtain well-defined solutions to the equations without any cut-offs or other arbitrary parameters. This is true even if higher-angular-momentum systems were exchanged which would have led to attractive singularities, and hence divergences, in the conventional approach. All arguments can be extended in a straightforward manner to the Bethe–Salpeter equation. (auth)

Strong (Baryon No. = 1)

Refer also to abstract 15328.

15337 SPECULATIONS CONCERNING LARGE-ANGLE MESON–NUCLEON SCATTERING AT HIGH ENERGIES. Domokos, G.; Karplus, R. (Univ. of California, Berkeley). Phys. Rev., 153: 1492-6(Jan. 25, 1967).

It is conjectured that under certain conditions the amplitude of meson-nucleon scattering at high energies and large angles is determined by the equal-time commutator of the meson source densities. Guessing the form of the commutator in question, it is found in particular that the πN elastic-scattering amplitude is proportional to the isoscalar magnetic form factor of the nucleon. A method is proposed to evaluate the experimental data in order to test asymptotic formulas of the type derived in this paper. Data on π^-p scattering at $p_{lab} = 12$ GeV/c taken from Orear et al. are found to be compatible with the theoretical prediction. (auth)

15338 BARYON RESONANCES. Tripp, R. D. (CERN, Geneva). pp 70-140 of Strong Interactions. Alvarez, L. W. (ed.). New York, Academic Press, 1966.

A survey is made of the baryon resonances with a special interest in exploring methods for determining their quantum numbers. A few remarks are given on elementary scattering theory. This is followed by a discussion of the Breit-Wigner equation for a resonant amplitude, with particular emphasis on those characteristic aspects which are identifiable in scattering experiments. As a specific example of such an analysis, the $Y_0^*(1520)$ is discussed in detail, which, being a multichannel resonance, is sufficiently complex as to contain all interesting aspects of the analysis. Finally, the other baryon resonances are surveyed emphasizing those which have been discovered more recently and those whose quantum numbers are still uncertain. The most recent developments in the field are discussed in Appendix I. Coefficients of angular distributions and polarizations are tabulated in Appendix II for all partial waves through $J = 3/2$. Tables of π-p and K-p kinematics are presented in Appendix III. 60 references.

15339 DESCRIPTION OF K^+p INTERACTIONS. Pilkuhn, H. (Univ. of Lund, Sweden). Acta Phys. Austr., Suppl. III, 217-28 (1966).

A review is given of the $K^+ + p$ and $K^- + p$ interactions. The topics covered include the low-energy $K^+ + p$ interaction, low-energy $\bar{K} + N$ interactions, the $Y^*(1405)$ as a virtual $\bar{K}N$ bound state, and $K^- + p$ interactions at higher energies. (J.F.P.)

15340 DYNAMICS OF THE $\pi - N$ SYSTEM. Hamilton, J. (NORDITA, Copenhagen). Acta Phys. Austr., Suppl. III, 229-59 (1966).

An explanation is given for $\pi + N$ scattering where the one-channel approximation is good, that is, up to 600 or 700 MeV and also including the case of several resonances at higher energies. The $\pi + N$ scattering is considered in terms of the basic interactions which produce the scattering, and dispersion relation methods are used. Inelasticity in $\pi + p \rightarrow \pi + N$ interactions, partial wave dispersion relations, and the peripheral method are considered. (J.F.P.)

15341 πN POLARIZATION AND REGGE POLES. Chiu, Charles B. (Univ. of California, Berkeley); Phillips, Roger J. N.; Rarita, William. Contract W-7405-eng-48. Phys. Rev., 153: 1485-7(Jan. 25, 1967). (UCRL-16940(Rev.)).

It is shown that the recent high-energy π^-p polarization data from CERN are explained in a natural way by the three-Regge-pole model. The prediction of this model for π^+p polarization differs greatly from that for π^-p polarization in the region where $|t| < 0.6$ (GeV/c)^2. In particular, in this region, the π^+p polarization has an opposite sign and comparable magnitude to that for π^-p. (auth)

15342 NUCLEON FORM-FACTOR SUM RULES FROM THE NONFORWARD RETARDED COMMUTATOR. Meyer, James W. (Univ. of Minnesota, Minneapolis). Phys. Rev., 153: 1652-6 (Jan. 25, 1967).

Using the equal-time commutators for current densities at equal times, five sum rules involving the nucleon form factors are derived by considering the Fourier transform of the retarded commutator of the currents evaluated between nucleon states of nonequal momenta. This leads to sum rules that contain not only the masses of the external vector particles, but also the momentum transfers, which give new sum rules and generalize previous sum rules. (auth)

15343 CONTRIBUTION OF $J \leq 3/2$ RESONANCES TO THE u-CHANNEL EXCHANGE POTENTIAL IN πN SCATTERING. Coulter, Philip W. (Univ. of Michigan, Ann Arbor); Shaw, Gordon L. Phys. Rev., 153: 1591-6(Jan. 25, 1967).

The contribution of recently found, highly inelastic πN resonances in the S_{31}, S_{11}, P_{11}, and D_{13} partial waves to the exchange u-channel generalized potential for πN scattering is calculated. The results of the complex phase-shift analyses for incident pion energies ≤ 1 BeV joined to smooth asymptotic functions are used to obtain the absorptive parts of the amplitudes. Dispersion integrals are performed over these amplitudes in the physical u region

and then related to the direct s channel by crossing. Finally, partial-wave projections in the direct s channel give the partial-wave generalized-exchange u-channel potential input to the N/D equations, which are solved for the phase shifts in the direct channel. The results are as follows: (i) Compared to the exchange of the nucleon and the N^*_{33} (1238 MeV), the S_{11}, S_{31}, and P_{11} u-channel continua have relatively small contributions to the s-channel unphysical cut. (ii) As for the P_{33} partial wave, the D_{13} contribution to the u-channel exchange potential is divergent as large s. Thus a cutoff is needed to solve the N/D equations. The effect of including D_{13} exchange is to make it harder to obtain agreement with experiment. (iii) The detailed shape of the P_{33} resonance reduces its contribution to the exchange potential by a factor of 0.75 as compared with the narrow-width approximation. (auth)

15344 PROPERTIES OF REACTIONS WITH PHOTON PRODUCTION BY MESONS. Chilton, Frank; Griffiths, David; Jabbur, R. J. (Argonne National Lab., Ill.). Phys. Rev., 153: 1610-16 (Jan. 25, 1967).

The properties of reactions $MB \rightarrow \gamma B^*$ are discussed. In particular, the boundary of the physical region is closer to the pole than for other processes, and only initial-state interactions have to be included: The absorptive peripheral model is used to calculate the cross sections for the following cases: $\pi^-p \rightarrow \gamma n$, $K^-p \rightarrow \gamma\Lambda$, $K^-p \rightarrow \gamma Y_0^*(1405)$. (auth)

15345 MODEL CALCULATION FOR THE $Y_0^*(1405)$ RESONANCE STATE. Dalitz, R. H. (Oxford Univ.); Wong, T. C.; Rajasekaran, G. Phys. Rev., 153: 1617-23(Jan. 25, 1967).

The $Y_0^*(1405)$ resonance state is considered in terms of a multichannel potential arising from vector meson (V) exchange between the baryon octet (B) and the pseudoscalar meson octet (P). The interactions are assumed to follow SU(3) symmetry; the only symmetry breaking included is that arising from the PB threshold separations, due to the P and B mass splittings. The resonance mass corresponds to a reasonable value ($f^2/4\pi = 1.25$) for the VPP coupling; the width then calculated is 27 MeV, comparable with the empirical value. The unitary impurities found in this $Y_0^*(1405)$ state are quite small, the octet admixtures being dominant and only 15% in total intensity. The effective range calculated for the $\bar{K}N$ scattering length is not large, being of order $1/m_V$. The relationship between the various choices possible for the definition of the resonance energy is also discussed explicitly for this case. (auth)

15346 MESON–BARYON COUPLING CONSTANTS IN A CURRENT–CURRENT MODEL. Graham, R. H.; Simmons, Walter A. (Purdue Univ., Lafayette, Ind.). Phys. Rev., 153: 1458-9(Jan. 25, 1967).

Methods recently developed by Chiu and Schechter for evaluation of matrix elements of bilinear products of hadron currents are combined with the PCAC (partially conserved axial-vector current) reduction technique to obtain approximate values of the meson-baryon coupling constants. Several current-current-type symmetry-breaking Hamiltonians are examined, and the results are compared with recent calculations using a Hamiltonian proportional to the space integral of the eighth component of the quark scalar density. (auth)

15347 CALCULATION OF THE $\pi^+\pi^-$ MASS DISTRIBUTION IN THE REACTION $\pi^-p \rightarrow \pi^-\pi^-N^{*++}$. Shpiz, J. M. (City Univ. of New York); Lai, K. W.; Webster, M. S. Contract AT(30-2)-Gen-16. Phys. Rev., 153: 1722-6(Jan. 25, 1967). (BNL-10503).

A one-pion-exchange (OPE) calculation is made of the $\pi^+\pi^-$ mass distribution from the $\pi^-p \rightarrow \pi^-\pi^-N^{*++}$ reaction in order to determine whether the σ enhancement at 400 MeV can be understood as a kinematical effect of the OPE production mechanism for N^{*++}. The results of the calculations tend to indicate that any structure in the $\pi^+\pi^-$ mass spectrum near 400 MeV cannot be explained in this way. (auth)

15348 DYNAMICS OF LOW-SPIN BARYON STATES. Golowich, E. (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 153: 1466-76(Jan. 25, 1967).

Baryon states of $\leq 3/2$ are studied using a dynamics based on an approximation to the Bethe-Salpeter equation, which includes baryon and meson-exchange forces. Considering only S- and P-wave vertices, a multichannel calculation is performed using an SU(6) description. A solution to a $56^+ : 70^-$ bootstrap model (superscript denotes parity) is found which qualitatively reproduces the experimental coupling constants and has a mass difference, M(70) – M(56) = 260 MeV. Analysis of symmetry-breaking effects in this model gives qualitative agreement with experiment. A solution to a $56^+ : 70^- : 20^+$ bootstrap is found with 56^+, 70^-, 20^+ approximately degenerate, thus supplying theoretical evidence for the existence of 20^+ in nature. The multiplet 20^- is found to exist only with a $56^+ : 70^- : 20^+ : 20^-$ model. A separate study of long-range forces in pseudoscalar meson-baryon scattering predicts an effect in the isospin-zero $P_{1/2}$ wave of the KN system and possibly the occurrence of a family of $P_{1/2}$ resonances belonging to the SU(3) multiplet, $\overline{10}$, but not containing the Roper effect. (auth)

15349 CONSTRAINTS ON πN PHASE-SHIFT ANALYSIS FROM ANGULAR DISTRIBUTIONS OF PRODUCTION REACTIONS. Arnold, Richard C.; Uretsky, J. L. (Argonne National Lab., Ill.). Phys. Rev., 153: 1443-8(Jan. 25, 1967).

A model-independent angular-momentum decomposition of the $\pi N \rightarrow \pi\pi N$ reaction amplitudes is exploited to relate angular distributions of each final-state particle with the absorption parameters η_l^J used in πN-scattering phase-shift analyses. This relation provides constraints in the form of lower bounds on $(1 - \eta_l^J)$ for specific sets of angular momentum and parity scattering states. Available data on production reactions from threshold to 600 MeV are examined and the consistency of various phase-shift solutions with these constraints is discussed. The Cence solution does not appear to agree with the energy dependence of the inelastic cross section, as deduced from available data on total, elastic, and charge-exchange πN cross sections. None of the existing phase-shift solutions at 290 MeV provides for absorption in partial waves with $J > 3/2$, while our analysis shows that production data require such absorption. (auth)

15350 SUBTRACTIONS IN DISPERSION RELATIONS. Woolcock, W. S. (London Univ.). Phys. Rev., 153: 1449-54 (Jan. 25, 1967).

Assuming the unitarity bound in the physical region on a partial-wave amplitude for an elastic scattering process, and assuming further that the amplitude satisfies a dispersion relation, it is shown that the necessity for subtractions in order to make the integral over the left-hand cut converge implies an oscillatory behavior of the discontinuity across the left-hand cut, the violence of the oscillations increasing with increasing number of subtractions. A theorem given by Sugawara and Kanazawa is provided with a rigorous proof and is applied to pion-nucleon and kaon-nucleon dispersion relations. (auth)

15351 BOOTSTRAP INVESTIGATION OF THE SAKATA TRIPLET-MESON SYSTEM. Nieto, Michael Martin (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 153: 1682-93(Jan. 25, 1967).

In order to investigate a possible quark-meson bootstrap, triplet scattering off an octet of degenerate pseudoscalar mesons (0.49 GeV) was studied. The exchange forces in the u channel were the triplets and any other P-wave multiplets that bootstrapped, and in the t channel were an assumed octet of vector mesons (0.89 GeV) with experimental values for G^V and G^T. A first-order N/D iteration technique was used, and a successful NN* bootstrap was obtained to check the calculational method. From an initial triplet, the masses and coupling constants obtained from one iteration were used as starting points for the next. Although a (3 $P_{1/2}$, 6* $P_{1/2}$, 15 $P_{3/2}$) bootstrap appeared possible, the solutions iterated into "ghosts" for large values of the coupling constants or cutoffs, and the triplet solution collapsed for smaller values. The interpretation is that low-mass (≈1 GeV) quarks are not expected to be found. (auth)

15352 PERIPHERAL MODEL FOR Ξ^- ASSOCIATED PRODUCTIONS. Ebel, M. E.; James P. B. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Rev., 153: 1694-1701(Jan. 25, 1967). (COO-881-82).

A single-particle exchange model with absorptive corrections is developed for application to meson-baryon inelastic scattering processes which are dominated by baryon exchange in the u channel. The model is applied to the process $K^- + p \rightarrow \Xi^- + K^+$, which appears to be a particularly clean example of a process in which baryon exchange plays a dominant role. The complex initial- and final-state elastic amplitudes required by the absorption model are determined from the Regge model of K^-p scattering proposed by Rarita and Phillips. The f/d ratio for baryon-pseudoscalar coupling, the only parameter in the model which is not determined externally, is found to be f/d = 0.555 if the vertex functions involved are assumed to be compatible with unbroken SU_3. The most interesting features of the Ξ^- production process are reproduced by the model as a result of the interference between the spin-1/2 Λ and Σ exchanges and the spin-3/2 $Y_1^*(1385)$ exchange. Although many features of the process studied are qualitatively reproduced by the model, it is concluded that this formulation of the peripheral model is not an adequate representation of a baryon exchange process. (auth)

15353 REGGE-POLE MODEL FOR HIGH-ENERGY BACKWARD π^+p SCATTERING. Chiu, Charles B.; Stack, John D. (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 153: 1575-8(Jan. 25, 1967). (UCRL-16745).

It is well known by now that both the π^+p and π^-p elastic-scattering reactions show peaks near the backward direction at high energy. The most striking difference between the two distributions in

the backward region is the dip in $d\sigma/du$ which appears in π^+p but not π^-p. It is shown that the present experimental situation in high-energy $\pi^\pm p$ scattering can be readily understood in terms of the exchange of the N and Δ Regge trajectories. The interpretation of the dip is that N trajectory exchange, which contributes only to π^+p, becomes numerically very small when the N pole moves near $J = -\frac{1}{2}$. (auth)

15354 REGGE-POLE FORMULAS FOR DIFFERENTIAL CROSS SECTIONS OF QUASI-TWO-BODY πN AND NN INTERACTIONS. Wang, Ling-lie (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 153: 1664-72(Jan. 25, 1967). (UCRL-17053).

Regge-pole formulas for differential cross sections of some quasi-two-body πN and NN interactions, which can have one or two meson trajectories exchanged, are given. The reactions treated are: $\pi N \to \pi\Delta(1236)$, $\pi N \to \omega\Delta(1236)$, $\pi N \to A_2N$, $\pi N \to \eta N$, $\pi N \to \eta\Delta(1236)$, $\pi N \to \rho N$, $\pi N \to \rho\Delta(1236)$, $NN \to N\Delta(1236)$, $NN \to NN^*(1500, \frac{3}{2}^-)$, $NN \to NN^*(1480, \frac{1}{2}^+)$. (auth)

15355 DOUBLE-OCTET REGGE-POLE MODEL WITH EXCHANGE DEGENERACY FOR CHARGE- AND HYPERCHARGE-EXCHANGE REACTIONS. Arnold, Richard C. (Argonne National Lab., Ill.). Phys. Rev., 153: 1506-19(Jan. 25, 1967).

A model for pseudoscalar-meson–baryon and pseudoscalar-meson–baryon-resonance hypercharge- and charge-exchange reactions at high energies is proposed, based on an octet of pairs of opposite-signature Regge poles. The model may be considered as an extension of the charge-exchange reaction model for K^-p used by Phillips and Rarita, incorporating SU(3) symmetry and exchange degeneracy. In addition, the universality hypothesis is employed to extend the model to B* production. The model thus extended contains only a few parameters (essentially only 2) and agrees with all available high-energy, small-momentum-transfer data on these reactions. The energy dependences (involving no free parameters) are very good; the universality hypothesis is satisfied within narrow experimental bounds, and SU(3)-symmetric normalizations are within a factor of 2 for most cross sections at high energy. (auth)

15356 TOTAL PION–PION CROSS SECTIONS FOR THE 2-GeV DI–PION MASS REGION. Biswas, N. N.; Cason, N. M.; Derado, I.; Kenney, V. P.; Poirier, J. A.; Shephard, W. D. (Univ. of Notre Dame, Ind.). Phys. Rev. Lett., 18: 273-6(Feb. 13, 1967).

Assuming single-pion exchange in the reaction $\pi + p \to \pi + \pi + B$ where B is the final-state baryon, the total $\pi^+\pi^-$, $\pi^-\pi^0$, and $\pi^-\pi^-$ cross sections from the elastic scattering amplitude in the forward direction were calculated. (auth)

15357 π–p CHARGE EXCHANGE POLARIZATION AND THE POSSIBILITY OF A SECOND ρ MESON. Logan, R. K. (Univ. of Illinois, Urbana); Beaupre, J.; Sertorio, L. Contract 00014-66-C00010-A05. Phys. Rev. Lett., 18: 259-63(Feb. 13, 1967).

A previous analysis of π–p charge exchange polarization is extended to 11.2-GeV data, and it is shown that the quantitative agreement is improved by the introduction of the meson(ρ'). Also the evidence for the existence of a ρ' is reviewed. Three models are considered: ρ + resonances, $\rho + \rho'$ + resonances, and $\rho + \rho'$. The predictions of the three models at different energies are presented. This provides an experimental test for distinguishing them. (J.F.P.)

15358 ANALYSIS OF THE MESON–BARYON VERTEX IN AN INFINITE MULTIPLET MODEL BASED ON THE GROUP $SL_{6,C}$. Ruehl, W. (CERN, Geneva). Nuovo Cimento (10), 47A: 355-82 (Feb. 1, 1967).

The meson-baryon vertex is considered which is symmetric under $SL_{6,C}$, and the mesonic form factors of the baryon octet are expressed in terms of integrals over algebraic functions of thirty-eight parameters. Seventeen integrations are performed with the help of group theory. The remaining twenty-one integrations cannot be done with analytic methods. Some analytic properties of the form factors are discussed. (auth)

15359 A Σπ MASS ENHANCEMENT AND A NEARBY TRIANGLE SINGULARITY. Month, M. (Univ. of Illinois, Urbana). Nuovo Cimento (10), 47A: 662-8(Feb. 1, 1967).

The enhancement observed in the $(\Sigma\pi)^+$ system at about 1660 MeV is described using a triangle diagram which has an intermediate state composed of a π^+ and a $Y_0^*(1520)$. In view of this, it is suggested that this enhancement does not represent the three-particle decay mode of the $Y_1^*(1660)$, but that rather it is the result of a final-state interaction mechanism. (auth)

15360 ABSORPTIVE CORRECTIONS TO ASSOCIATED PRODUCTION OF STRANGE BARYON AND MESON RESONANCES IN πp SCATTERING. Eysel, F.; Locher, M. P.; Wessel, H. (Univ., Bonn). Z. Phys., 199: 411-21(1967).

Absorptive corrections are calculated for the reactions $\pi^+p \to K^{*+}\Sigma^+(K^{*+}Y_1^{+})$ mediated by K-exchange and $\pi^+p \to K^+Y_1^{*+}$ with K*-exchange. The effect of the finite width of the resonances is included. Numerical results are given for 5 and 8 GeV/c. (auth)

15361 DYNAMICAL MODEL FOR NEGATIVE-PARITY REGGE TRAJECTORIES IN THE PION–NUCLEON SYSTEM. Carruthers, P. (Cornell Univ., Ithaca, N. Y.); Nieto, Michael Martin. Phys. Rev. Lett., 18: 297-9(Feb. 20, 1967).

The Cook–Lee model for the "second" pion-nucleon resonance $(1512, \frac{3}{2}^-)$ was generalized to arbitrary initial and final baryons. It is shown that the virtual production of S-wave ρ mesons included in $\pi + S^+ \to \rho + S^+$, where S^+ is the set of all positive-parity resonances originating in the nucleon and the 3-3 resonance, generates the pair of trajectories S^- comprised of a series with $(T, J^P) = (\frac{1}{2}, \frac{3}{2}^-)$, $(\frac{1}{2}, \frac{7}{2}^-)$, ... and $(\frac{1}{2}, \frac{5}{2}^-)$, $(\frac{1}{2}, \frac{9}{2}^-)$, ... In addition, subsidiary trajectories $(\frac{1}{2}, \frac{1}{2}^-)$, $(\frac{1}{2}, \frac{5}{2}^-)$, ... and $(\frac{3}{2}, \frac{1}{2}^-)$, $(\frac{3}{2}, \frac{5}{2}^-)$, ... are obtained. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstract 15354.

15362 WEAK-BINDING COMPARISON OF TWO NORMALIZATION CONDITIONS. Cawley, Robert G. (Clarkson Coll. of Tech., Potsdam, N. Y.). Phys. Rev., 153: 1712-21(Jan. 25, 1967).

A weak-binding, essentially nonrelativistic, model is used to compute approximately the wave-function renormalization constant for the deuteron. The method is to compute the phenomenological deuteron coupling constant from the deuteron electromagnetic form factor assuming an unsubtracted dispersion relation. This value is then inserted into the "Z expansion" for the inverse deuteron propagator function. The result in our model is Z = 0 for both the scalar case and the vector case. All propagator CDD (Castillejo-Dalitz-Dyson) residues also come out zero. (auth)

Particle Invariance Principles and Symmetries

General

15363 SPONTANEOUS BREAKDOWN OF SYMMETRIES. Suranyi, P. (Central Research Inst. for Physics, Budapest). Acta Phys. Austr., Suppl. III, 67-91(1966).

The discussion of spontaneous breakdown of symmetries includes a general description of spontaneous breakdown theories, a discussion of the Goldstone theorem, and physical applications of the spontaneous breakdown theories. Some of the common problems arising at the physical application of these theories are also mentioned. (J.F.P.)

15364 THEORY OF SPONTANEOUS SYMMETRY BREAKDOWN AND THE APPEARANCE OF MASSLESS PARTICLES. Frishman, Y.; Katz, A. (Weizmann Inst. of Science, Rehovoth, Israel). Acta Phys. Austr., Suppl. III, 92-112(1966).

A previous definition of broken symmetry as a symmetry transformation depending on a continuous parameter which leaves the Hamiltonian or Lagrangian invariant but changes the vacuum is adopted, and it is shown by means of a counter example that massless particles need not arise. The infinitesimal generator is defined, and its properties are discussed. Broken symmetry is redefined in terms of the infinitesimal transformations, and sufficient conditions are given under which the energy spectrum of the system features no gap, namely that every neighborhood of the origin in the momentum-energy space contains points of the spectrum other than the one corresponding to the ground state. Sufficient conditions for the existence of massless particles, regardless of the existence of spurious states, are presented, and examples in which the symmetry breaking condition is realized are given. (J.F.P.)

15365 AXIAL FORM FACTORS BY THE ALGEBRA OF CURRENTS. Jengo, R. (Univ., Trieste, Italy). Acta Phys. Austr., Suppl. III, 151-62(1966).

Previous results are presented in which the matrix elements between nucleon states of the equal-time commutation relations of the algebra of SU(2) × SU(2) were considered. From these commutators relations among the matrix elements of vector and axial currents are obtained. (J.F.P.)

15366 DEGENERATE REPRESENTATIONS OF NON-COMPACT LIE GROUPS. Raczka, R. (International Center for Theoretical Physics, Trieste, Italy. Inst. of Nuclear Research, Warsaw). Acta Phys. Austr., Suppl. III, 260-93(1966).

The discussion of degenerate representations of noncompact Lie groups covers problems in the theory of representations of noncompact groups, group representation and geometry of homogeneous spaces, discrete most degenerate representations of SO(p,q) groups ($p \geq q > 2$), SO(p,2), and Lorentz-type groups, and irreducibility and unitarity. Also a review and discussion of the derived representations $D^{\pm}(H_n^p)$ of the group SO(p,q), and a discussion of discrete degenerate representations of U(p,q) groups are given. (J.F.P.)

15367 HIGHER SYMMETRIES. **Low, F. E. (Massachusetts Inst. of Tech., Cambridge). Acta Phys. Austr., Suppl. III, 316-37(1966).**

Symmetries higher than SU(3) are discussed. The topics considered include static SU(6), transformation properties, and a contradiction with unitarity, Coleman's counterargument, discussion of another attempt to solve this problem, and consequences of the theory at $p_z \approx \infty$. (J.F.P.)

15368 RELATIVISTIC INVARIANCE AND LOCAL FIELDS. **Matthews, P. T. (Imperial Coll. of Science and Tech., London). Acta Phys. Austr., Suppl. III, 338-57(1966).**

The relation between internal symmetries and relativistic invariance is studied in more general terms, and the achievements and limitations of $\tilde{U}(12)$ and related theories are discussed in this light. Poincaré invariance and auxiliary operators, causality and local fields, and higher symmetries are discussed. (J.F.P.)

15369 WHAT IF ANYTHING IS SU(6) SYMMETRY? **Stichel, P. (Univ., Hamburg. Deutsches Elektronen-Synchrotron, Hamburg). Acta Phys. Austr., Suppl. III, 358-68(1966).**

A critical review of SU(6) is presented in which the violation of some basic physical concepts caused by applying formal group theoretical methods to elementary particle physics is considered. The connections between the different approaches which are of a logical, quasilogical or nonlogical nature are discussed. Relativistic invariant, nonlocal models, construction of a larger group G, broken symmetries, and current algebra are covered. (J.F.P.)

15370 SPIN AND LORENTZ EXTENSIONS OF INTRINSIC SYMMETRY GROUPS. **Doebner, H. D.; Hegerfeldt, G. C. (Institut fuer Theoretische Physik, Marburg, Ger.). Acta Phys. Austr., Suppl. III, 369-79(1966).**

Starting from three heuristic physically plausible postulates, a purely group theoretical method for constructing a unique spin and Lorentz extension for a large class of intrinsic symmetry groups without using a model Lagrangian or other field theoretic techniques is given. The principles involved, the main theorem, comparison with another method, and the Lorentz extension are considered. (J.F.P.)

15371 RELATIVISTIC SU(6). **Fronsdal, C. (International Center for Theoretical Physics, Trieste, Italy). Acta Phys. Austr., Suppl. III, 380-405(1966).**

The discussion of relativistic SU(6) includes a general discussion of SU(6) theory, some representations of SL(n,C), multiplet assignment and Yukawa coupling, and applications. (J.F.P.)

15372 ATTEMPTS AT UNDERSTANDING THE MASS SPECTRA OF ELEMENTARY PARTICLES. **Bisiacchi, G.; Fronsdal, C. (International Center for Theoretical Physics, Trieste, Italy). Acta Phys. Austr., Suppl. III, 406-27(1966).**

In the discussion of the mass spectra of elementary particles the sense in which the mass operator for baryons and mesons is equal, transformation of the mass operator like a component of an irreducible SL(6) tensor and under Lorentz transformation, mixing between different SU(6) representations in the framework of SL(6,C), and qualitative features of the mass spectrum for the higher SU(6) multiplets are considered. The topics covered are phenomenology, the irreducible operator SL(6,C), Lorentz transformation properties, and an operator without mixing. (J.F.P.)

15373 PRESYMMETRY. **Ekstein, H. (Argonne National Lab., Ill.). Phys. Rev., 153: 1397-1402(Jan. 25, 1967).**

Even in the presence of external fields, space-time symmetry implies nontrivial relations between observables at one time, i.e., kinematical relations. Symmetry operations at one time—translations, rotations, and (for Galilei symmetry) velocity shifts—can be performed on observation-producing and on state-producing instruments, regardless of the existence of an external field. Furthermore, it is possible to give an operational definition of every initial state intrinsically, i.e., regardless of the external field. The precise statement of this empirical fact explains, for example, why a particle in an external field has integral or half-integral eigenvalues of the spin, why a Hamiltonian exists even in the presence of a time-dependent external field, and why (for Galilei symmetry) the canonical commutation relations are still valid, although the full space-time symmetry from which these results can be derived has been destroyed. It is pointed out that the rigorous validity of kinematical relations, in spite of strong breaking of the underlying space-time symmetry, is analogous to the rigorous validity of equal-time current commutation rules, in spite of the breaking of the underlying U(e) symmetry. (auth)

15374 A COMPUTER PROGRAM FOR COMPUTATION OF IRREDUCIBLE REPRESENTATIONS OF SU(3). **Herttua, M.; Jauhno, P. (Technical Univ. of Helsinki). Ann. Acad. Sci. Fenn., Ser. A VI, 208: 4p.(1966).**

The decomposition $(m_1,n_1) \times (m_2,n_2) = \Sigma\sigma_{(m,n)}\,(m,n)$ for the computer program is computed simply by constructing the product diagram and subtracting from it the (m,n) multiplets. Several computed Clebsch-Gordan series are shown. The program was written in Algol and run on an Elliot-503. (J.F.P.)

15375 GRAPHICAL REPRESENTATION OF CPT. **Ramakrishnan, Alladi (MATSCIENCE, Madras). J. Math. Anal. Appl., 17: 147-50(Jan. 1967).**

For the graphical representation of CPT it is found that if the propagators are decomposed into positive and negative energy parts, the particles are on the energy shell and the symmetry operations on free particles can be taken over directly to all orders of perturbation. Thus it suffices to define the operation of CPT for only free particles in Feynman graphical formalism and demonstrate how it can be carried over to interacting fields. (J.F.P.)

15376 GROUP THEORY AND ITS PHYSICAL APPLICATIONS. **Falicov, L. M. Chicago Lectures in Physics. Chicago, University of Chicago Press, 1966. 229p.**

A selection of topics in the theory of groups and its application to physical problems is presented. The topics covered include fundamental definitions and theorems; theory of representations; relationship to quantum mechanics; direct product theory; applications to crystal and molecular symmetry, applications to solid state physics; time-reversal symmetry, and continuous groups. (L.B.S.)

Applications (Electromagnetic and Weak)

Refer also to abstracts 15315 and 15387.

15377 SU(6)W ALGEBRA AND THE COMMUTATORS OF ELECTRIC DIPOLES AT INFINITE MOMENTUM. **Ademollo, M. (Univ., Florence. Istituto Nazionale di Fisica Nucleare, Florence); Gatto, R.; Longhi, G.; Veneziano, G. Phys. Rev., 153: 1623-33(Jan. 25, 1967).**

The saturation of the $SU(6)_W$ algebra at infinite momentum is discussed. A possible physical interpretation of the tensor generators of $SU(6)_W$ in terms of an assumption of partial conservation is critically analyzed. The implied occurrence of singularities in the tensor amplitudes requires a careful definition of a limiting procedure defining the tensor charges. A collinear limiting procedure, which relates the tensor charges to the total magnetic moments, appears as the most convenient one. The matrix elements of the tensor charges are then compared in the infinite-momentum limit with those of the electric dipoles, and the following implications are exhibited: The charge radii of baryons are pure F; the D/F ratio of axial charges equals the corresponding ratio for the total baryon magnetic moments; a simple relation exists among the isovector total moment of the nucleon, the axial renormalization constant, and the charge radius of the proton; and an extended form of universality holds for tensor and axial currents. The saturation of the unitary symmetric part of the commutators is also discussed, particularly in connection with the possible occurrence of Schwinger terms. (auth)

15378 MASS FORMULAE AND SU_3 SYMMETRY. **Lee, T. D. (Columbia Univ., New York). pp 311-26 of Weak Interactions and High-Energy Neutrino Physics. Lee, T. D. (ed.). New York, Academic Press, 1966.**

Various topics of different speculative nature on the approximate validity of the SU(3) symmetry are covered. The appropriate mass formulas for the known 8 pseudoscalar mesons, 9 vector mesons, 8 spin-½ baryons and the 10 spin-3/2 baryons are listed. A brief review is given of some of the basic properties of the SU(3) group and its irreducible representations. Basic assumptions concerning the strong interactions are stated, and are followed by a discussion of some immediate consequences of these assumptions which lead to the mass formulas for the pseudoscalar octet η, K, and π, and to the spin-½ octet N, Σ, Λ and Ξ. A few preliminary remarks are made about broken symmetry, after which it is shown—for the 9 vector mesons—how the ninefold degeneracy can be understood as a dynamical approximation by considering the triplet model. The broken SU(3) symmetry is associated with the existence of three different, but basic, massive particles with

very strong interactions. The stability of the basic triplet particles against the weak interactions is then examined. (L.B.S.)

15379 ELECTROMAGNETIC PROCESSES AND INTEGER QUARK CHARGE. Komar, A. A.; Slad, L. M. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 5: 53-6(Jan. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 67-70(Jan. 15, 1967).

In order to reveal the possible effects of j_0, a component of the integer quark charge which has the properties of a unitary singlet, a number of electromagnetic processes are analyzed by group methods. These include: radiative decays of vector mesons, photoproduction of pseudoscalar and vector mesons from nucleons, and processes in colliding electron-positron beams proceeding via production of mesons (ω) and (ϕ). It is found that the presence of the singlet component j_0 has no effect whatever on the relation between photoproduction amplitudes. But the relation between the amplitudes of the radiative decays of vector mesons turns out to be quite sensitive to the presence of j_0. (J.F.P.)

15380 VIOLATION OF T-INVARIANCE IN RESONANCE SCATTERING OF PHOTONS BY NUCLEI. Burgov, N. A.; Lobov, G. A. Zh. Eksp. Teor. Fiz., 52: 527-32(Feb. 1967). (In Russian).

T-odd angular correlation in resonance scattering of photons by polarized nuclei is calculated. The effect of an external magnetic field on the correlation is taken into account. Numerical values of the correlation coefficients are presented for a large number of nuclei. The experimental data and predictions of various hypotheses regarding the degree of violation of T-parity in processes involving hadrons are discussed. The problem of experimental investigation of T-odd angular correlation by means of the Mössbauer effect is discussed. (auth)

15381 QUARK-MUONIC CURRENTS AND VIOLATION OF CP INVARIANCE. Sakharov, A. D. JETP Lett. (USSR)(Engl. Transl.), 5: 27-30(Jan. 1, 1967).

Translated from Zh. Eskp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 36-9(Jan. 1, 1967).

A hypothesis is considered in which the violation of CP invariance in K_2^0 decay is ascribed to the difference between the phase constants for ordinary and strange quarks. (J.F.P.)

15382 PION MASS DIFFERENCE FROM SU_2 CURRENT ALGEBRA AND QUARK MODEL. Frenkel, A.; Posch, M.; Suranyi, G.; Suranyi, P. (Central Research Inst. of Physics, Budapest). Nuovo Cimento (10), 47A: 626-33(Feb. 1, 1967).

A new formula for the electromagnetic mass difference between pions is derived on the basis of the isospin algebra SU_2 and of a relation valid in a field theory with no fundamental boson fields. The contribution of the first two two-particle intermediate states gives +9.1 MeV for the mass difference instead of the experimental value +4.7 MeV. The possible causes of this discrepancy are discussed and the method is compared with other approaches to the same problem. (auth)

Applications (Strong)

15383 (CERN-66-29(Vol.2)) PROCEEDINGS OF THE 1966 CERN SCHOOL OF PHYSICS, NOORDWIJK AAN ZEE, JUNE 6-18, 1966. (European Organization for Nuclear Research, Geneva (Switzerland)). Dec. 20, 1966. 132p. Dep. mn.

A discussion of the symmetries of strong interactions is given and includes quarks, unitary symmetry, group representations, irreducible representations, Clebsch-Gordan coefficients, irreducible tensor operators, the mass formula, and coupling constants. Also considered are weak interactions, SU(2) group, mesons in SU(6), and baryons. Aspects of meson (μ) physics are discussed. These include meson (μ) capture, the phenomenology of meson (μ) decay, meson (μ)-electron universality, and meson (μ) static properties. Symmetry and asymmetry in physics is also discussed. (J.F.P.)

15384 (JINR-P2-3087) MEZON-BARIONNOE RASSEYANIE I SU(6). (Meson-Baryon Scattering and SU(6) Group). Zaslavskii, A. N.; Tybor, V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 18p. (In Russian). Dep. mn.

A comparison is made with the experiments on meson-baryon scattering of those predictions of the SU(6) group which remain valid in the framework of the relativistic $SU_x(6)$ group. Although in certain cases there is an agreement, on the whole a sharp divergence is observed in the momentum region up to 4 GeV/c.(auth)

15385 SYMMETRIES OF STRONG INTERACTIONS. Glashow, S. L. (Univ. of California, Berkeley). pp 189-225 of Strong Interactions. Alvarez, L. W. (ed.). New York, Academic Press, 1966.

The lectures presented on strong interaction symmetries are largely concerned with the eightfold way, which includes the traditional symmetries of strong interactions and also many more transformations that are only approximate symmetries of nature. The traditional symmetries and higher symmetries are first listed. Mathematical preliminaries of the Lie groups, SU(2) group, SU(3) group, tensors, and the Sakata model vs. the eightfold way are then discussed. Applications of the eightfold way are discussed, which include the Gell-Mann-Okubo mass formula, classification of newly discovered resonances, coupling constants, and cross sections. Finally, departures from the eightfold way are considered for the medium-strong interactions, electromagnetism, and the weak interactions. (L.B.S.)

15386 COLLINEAR GROUPS AND DYNAMICAL APPROACH TO SYMMETRY. Buccella, F. (Univ., Florence). Acta Phys. Austr., Suppl. III, 163-81(1966).

The discussion of collinear groups for a dynamical approach to symmetry is given using the approach suggested by Dashen and Gell-Mann. They consider the sixteen covariants one can construct from two Dirac spinor fields. (J.F.P.)

15387 CURRENT ALGEBRAS AND CALCULATIONS IN BROKEN SYMMETRIES. Moffat, J. W. (Univ. of Toronto). Acta Phys. Austr., Suppl. III, 113-50(1966).

The connection of higher symmetries to the Lie algebra of the space integrals of the time components of currents is studied. Simple field theory models which give rise to algebraic structures are considered, and symmetry properties of baryons and mesons are developed on the basis of the unitary symmetric Lagrangian describing Yukawa interactions. The group generators of SU(3) and properties of the hadron current conservation and the role of current algebras and convergent dispersion relations are studied. The Goldberger-Treiman and Adler-Weisberger relations are derived and considered in detail. The problem of vector meson interactions with the hadron current and the derivation of mass relations from current algebras and field theory are discussed. A field theory model is used to calculate symmetry breaking corrections to mass sum rules in SU(3). Finally, weak interactions and their relation to the current algebra corresponding to the group $SU(3) \times SU(3)$ are studied within the context of the universality of weak decay processes. (J.F.P.)

15388 MESON-MESON COUPLING CONSTANTS IN BROKEN SU(3) AND THE ALGEBRA OF CURRENTS. Rockmore, Ronald (Rutgers-The State Univ. of New Jersey, New Brunswick). Phys. Rev., 153: 1490-1(Jan. 25, 1967).

Sum rules are obtained for meson-meson coupling constants in broken SU(3) with symmetry-breaking effects taken into account to first order, using the algebra of currents and the hypothesis of partial conservation of axial-vector currents. In particular, enlarged sets of coupling-constant sum rules are obtained for the vector-octet-pseudoscalar-octet-vector-octet (V_8-P_8-V_8) coupling constants and for the V_8-P_8-P_8 coupling constants. The corresponding two-parameter families of symmetry-breaking interaction Hamiltonians are also given. (auth)

15389 NONET OF 2^+ MESONS AND BROKEN SU(3). Gautam, V. P.; Ghose, P. (Indian Association for the Cultivation of Science, Calcutta). Phys. Rev., 153: 1460-5(Jan. 25, 1967).

Coupling-constant sum rules for the coupling of the recently proposed reducible nonet of 2^+ mesons to (a) a pair of pseudoscalar mesons and (b) a pseudoscalar and a vector meson are derived in the framework of broken SU(3). The main feature of the paper is the use of Okubo's nonet assignment to relate the parameters characterizing the coupling of the singlet to those of the octet in the presence of symmetry breaking, thus obtaining more sum rules. At present only three of these sum rules in case (a) can be checked experimentally, and it is found that present experimental evidence is consistent with the nonet assignment. (auth)

15390 SU(6)W AND BARYON RESONANCES OF ODD PARITY. Capps, Richard H. (Northwestern Univ., Evanston, Ill.). Phys. Rev., 153: 1503-5(Jan. 25, 1967).

An $SU(6)_W$-symmetric dynamical model, used previously to predict quantum numbers and branching ratios of even-parity meson resonances, is extended to odd-parity baryon resonances. It is assumed that meson exchange forces of the tensor type dominate. The relative sizes of the tensor forces in all meson-baryon states are given by the assumed $SU(6)_W$ symmetry. The matrix elements of the tensor forces corresponding to the lowest orbital angular momentum in odd-parity states are S-D-wave transition elements. Those S-D states in which the largest forces exist are assumed to resonate. SU(3) singlet states of $j = \frac{1}{2}$ and $\frac{3}{2}$ are predicted; these may be identified with the 1405- and 1520-MeV Y_0^* particles. The predicted octet resonances correspond to the two distinct f/d ratios 1 and $-\frac{1}{3}$. The predicted results are compared with experimental data on the branching ratios of the 1660- and 1765-MeV Y_1^* parti-

cles, and with the recent measurements of the relative phases of different $\overline{K}N \rightarrow \pi\Lambda$ resonant amplitudes by Smart, Kernan, Kalmus, and Ely. Some experiments are suggested that would test the model further. (auth)

15391 VIOLATION OF CP INVARIANCE, C ASYMMETRY, AND BARYON ASYMMETRY OF THE UNIVERSE. Sakharov, A. D. JETP Lett. (USSR)(Engl. Transl.), 5: 24-7(Jan. 1, 1967). Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 32-5(Jan. 1, 1967).

A possible explanation of C asymmetry in the hot model of the expanding universe is pointed out by making use of the effects of CP invariance violation. An approximate character for the baryon conservation law is proposed to explain baryon asymmetry. (J.F.P.)

15392 SOME NEW LINEAR AND QUADRATIC MASS FORMULAS FOR BARYONS. Soln, J. (Univ. of California, Los Angeles). Nuovo Cimento (10), 47A: 609-15(Feb. 1, 1967).

Two linear and two quadratic mass formulas for baryons are derived in broken SU_3 symmetry. From the linear mass formulas follow the mean-mass version of the Gell-Mann-Okubo formula and the Coleman-Glashow formula. From the two quadratic mass formulas, a quadratic mass formula analogous to the linear Coleman-Glashow formula is derived. The comparison of this formula with experiments shows excellent agreement. (auth)

15393 APPLICATIONS OF A UNIQUE GROUP EMBEDDING OF INTERNAL SYMMETRY GROUPS AND SU(2): SPIN-EXTENSIONS FOR G_2 AND FOR THE Sp(6)-TRION MODEL. Doebner, H. D.; Hegerfeldt, G. C. (Institut fuer Theoretische Physik, Marburg, Ger.). Z. Phys., 199: 369-77(1967).

A recently proposed method of embedding SU(2) and an internal symmetry group G into a bigger group $\tilde{G}$ is applied to construct a spin extension of G_2 and Sp(6). Because G_2 and Sp(6) possess a generalized quark model the embedding group can be proved to be unique and to be given by Sp(14) resp. O(12) for G_2 resp. Sp(6). For a particle classification splittings are calculated and tabulated for $Sp(14) \downarrow G_2 \times SU(2)$ and $O(12) \downarrow Sp(6) \times SU(2)$. The identification of low dimensional irreducible representations of O(12) is quite satisfactory whereas an unreasonable number of unobserved particles are needed to fill up the supermultiplets of the spin extension Sp(14) of G_2. (auth)

15394 SU(3) SYMMETRY TESTS FOR REGGE RESIDUES. Barger, V.; Olsson, M. (Univ. of Wisconsin, Madison). Phys. Rev. Lett., 18: 294-6(Feb. 20, 1967).

Six independent combinations of cross section data involving meson-nuclear charge-exchange amplitudes at the forward direction are analyzed in terms of ρ ($J^P = 1^-$, $I^G = 1^+$) and A ($J^P = 2^+$, $I^G = 1^-$) Regge-exchange model. SU(3) tests for the ratios of the Regge-pole residues give $\gamma_{\rho NK}/\gamma_{\rho\pi\pi} = 1.12 \pm 0.12$ and $\gamma_{ANK}/\gamma_{A\pi\eta} = 1.07 \pm 0.15$, consistent with exact symmetry values of 1. (auth)

15395 SU(4) MODEL FOR STRONG INTERACTION. Baier, R.; Urban, P. (Univ., Graz). Acta Phys. Austr., 24: 31-6 (1966). (In German).

An SU(4) model was proposed which is a formal expansion of the SU(3) quark model. The pseudoscalar mesons and the vector mesons were assigned to the SU(4) regular representation. The baryons and $^3/_2^+$ resonances were assigned in two nonequivalent 20-dimensional representations which are contained in the $4 \otimes 4 \otimes 4$ product. A higher symmetry was proposed which connects the inner SU(4) symmetry with the particle spin. (tr-auth)

Quantum Field Theories

Refer also to abstract 15280.

15396 (JINR-P2-3112) ALGORITM, POZVOLYAYUSHCHII NAITI SOBSTVENNYE FUNKTSII I SOBSTVENNYE ZNACHENIYA OPERATORA ENERGII DLYA NEKOTORYKH VARIANTOV KVANTOVOI TEORII POLYA. **(Algorithm Allowing to Find Eigenfunctions and Eigenvalues of the Energy Operator for Some Variants of Quantum Field Theory).** Zastavenko, L. G. **(Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 9p. (In Russian). Dep. mn.**

A constructive method for calculation of the energy operator eigenfunctions and eigenvalues fit for the whole class of quantum field theory variants is given. The method is illustrated by the example of a neutral scalar field with the $g\phi^4$ selfaction. (auth)

15397 (JINR-P2-3113) K KVANTOVOI TEORII SKALYARNOGO NEITRAL'NOGO POLYA S SAMODEISTVIEM $g\phi^4$ V SLUCHAE ODNOI PROSTRANSTVENNOI STEPENI SVOBODY. (To the Quantum Theory of Scalar Field With $g\phi^4$ Self-action in the Case of One Spatial Dimension). Zastavenko, L. G. (Joint Inst for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 9p. (In Russian). Dep. mn.

A formulation of a relativistic model in quantum field theory, which is not based on the theory of perturbations, is given. (auth)

15398 (JINR-P2-3114) CHETYREKHMERNAYA UNITARNAYA RELYATIVISTSKAYA MODEL KVANTOVOI TEORII POLYA BEZ RASKHODIMOSTEI. **(Four-Dimensional Unitary Relativistic Model of Quantum Field Theory Without Divergences).** Volkov, M. K. **(Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 17p. (In Russian). Dep. mn.**

The Green functions and the scattering amplitude of scalar particles are investigated in the four-dimensional relativistic Bialynicki-Birula's model. It is shown that the ultraviolet divergences are absent and the condition of the unitarity of the S-matrix is fulfilled in the second order of the perturbation theory with an expansion in Δm (nucleon mass difference in two possible states). (auth)

15399 (NYO-2262TA-147) FUNCTIONAL METHODS FOR SOFT PHOTONS AND SOFT PIONS. **Fried, H. M. (Brown Univ., Providence, R. I. Dept. of Physics). Feb. 1967. Contract AT(30-1)-2262. 25p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.**

Practical aspects of a class of no-recoil approximations to the equations of quantum field theory are considered. The topics discussed are functional preliminaries, soft photons in quantum electrodynamics, and soft mesons (π) in ps-ps theory. (J.F.P.)

15400 NONLINEAR SPINOR THEORY IN TERMS OF VACUUM EXPECTATION VALUES. **Mitter, H. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Acta Phys. Austr., Suppl. III, 42-66(1966).**

The system of equations for the vacuum expectation values of certain products of field operators (the n-point functions) of a nonlinear cubic spinor theory is considered. The two-component theory (only spin) and the four-component theory (spin and isospin) are discussed. (J.F.P.)

15401 FINITE FORMULATION OF RENORMALIZATION METHOD. **Sekine, K. (Institut Henri Poincare, Paris). Acta Phys. Austr., Suppl. III, 440-63(1966).**

The method of renormalization is proposed in order to eliminate the divergence difficulty in quantum field theory. The method is summarized in general terms. A simple model and the general method are considered. (J.F.P.)

15402 BETHE-SALPETER EQUATION AND GOLDSTONE BOSONS IN QUANTUM ELECTRODYNAMICS. **Willey, R. S. (Univ. of Pittsburgh). Phys. Rev., 153: 1364-71(Jan. 25, 1967).**

The relevance of the Goldstone theorem to quantum electrodynamics with zero bare mass for the electron is studied. Subject to the necessary approximations, it is concluded that the Goldstone theorem has no physical consequences for this theory. (auth)

15403 THE FORMULATION OF QUANTUM ELECTRODYNAMICS WITH STRONG LORENTZ CONDITION. I. HEISENBERG PICTURE. **Lukierski, J. (Univ. of Wroclaw). Acta Phys. Pol., 31: 63-94(Jan. 1967).**

The class of formulations of QED with nonvanishing four-divergence operator $A^{\mu}_{,\mu}$ is investigated. It is assumed that the operator $A^{\mu}_{,\mu}$ is a generalized free field with indefinite metric, containing poles of arbitrary order. Unitary transformation, which eliminates the longitudinal part from the four-potential and allows imposing of the strong Lorentz condition is explicitly introduced. In the modified picture only gauge-invariant operators remain, and the gauge dependence is transferred onto the state vector. The gauge modes are described by means of functional parameter, which in calculations of physical processes can be kept fixed. The consistency of strong operator conditions with canonical formalism is discussed, and common features with the formalism describing gauge transformations of third kind are pointed out. For the completeness of the considerations the radiation gauge formulation, with Coulomb interaction separated, by means of a second transformation is obtained. (auth)

15404 INVESTIGATION OF THE LAGRANGIAN FOR NONLINEAR SPINOR AND SCALAR FIELDS. **Gisin, B. V. Zh. Eksp. Teor. Fiz., 52: 502-7(Feb. 1967). (In Russian).**

Some relations which must be observed in order that particle-like solutions of the simplest cases of nonlinear spinor and scalar fields exist are derived. Despite the restricted validity of the Lagrangians (for example they cannot be employed for describing neutral particles) such relations may be useful for choosing a real nonlinear Lagrangian. (auth)

15405 ANGULAR MOMENTUM UNCERTAINTY RELATION AND THE THREE-DIMENSIONAL OSCILLATOR IN THE COHERENT STATES. **Nieto, Michael Martin (State Univ. of New York, Stony Brook). Phys. Rev. Lett., 18: 182-5(Jan. 30, 1967).**

An angular momentum uncertainty relation is obtained in terms of sine and cosine operators that have a meaning even in a second-quantization formalism. For a three-dimensional oscillator in coherent states the new uncertainty product is a minimum for large ΔL_z. Even for small ΔL_z the uncertainty product is very small. (auth)

15406 INTEGRAL REPRESENTATIONS OF ANALYTIC FUNCTIONS AND JOST–LEHMANN–DYSON FORMULA. Bros, J.; Itzykson, C.; Pham, F. (Centre d'Etudes Nucleaires, Saclay, France). Ann. Inst. Henri Poincare, Sect. A, 5: 1-35(1966). (In French).

The general representation formulas for analytic functions are applied in the case of the Dyson domains. This gives an equivalent form of the Jost-Lehmann-Dyson formula. The method is first described in the simpler case of tubes with convex conical basis. (auth)

15407 COVARIANT POLE APPROXIMATION IN QUANTUM ELECTRODYNAMICS. Ecker, K.; Urban, P. (Univ., Graz). Acta Phys. Austr., 24: 75-86(1966). (In German).

Kessler made an approximate calculation of processes in which, under given conditions, virtual fermions can be produced from real fermions. The approximation method is carried out in covariant form for the almost real fermion and the almost π meson. The expansion of the application possibilities by Lorentz transformation is illustrated. (J.S.R.)

15408 MEASUREMENT OF 2e/h USING THE AC JOSEPHSON EFFECT AND ITS IMPLICATIONS FOR QUANTUM ELECTRODYNAMICS. Parker, W. H. (Univ. of Pennsylvania, Philadelphia); Taylor, B. N.; Langenberg, D. N. Phys. Rev. Lett., 18: 287-91(Feb. 20, 1967).

Using the ac Josephson effect, it was determined that $2e/h = 483.5912 \pm 0.0030$ MHz/μV. The implications of this measurement for quantum electrodynamics are discussed as well as its effect on the knowledge of the fundamental physical constants. (auth)

15409 EQUAL-TIME COMMUTATOR IN A SOLVABLE MODEL. Bell, J. S. (CERN, Geneva). Nuovo Cimento (10), 47A: 616-25(Feb. 1, 1967).

An equal-time commutator in the Lee model is examined. It is found that a related sum rule does not have the canonical value. On the other hand, in the corresponding zero-energy theorem the canonical value is correct. (auth)

15410 ON THE COMPOSITENESS CRITERIA IN FIELD THEORIES. III. Choudhury, S. Rai (Moscow State Univ.); Srivastava, P. K. Nuovo Cimento (10), 47A: 634-41(Feb. 1, 1967).

The equivalence of a composite particle with an elementary one with vanishing wave-function renormalization is proved in the three-particle sector of the Lee model. The composite model chosen is one in which, in addition to usual Lee-model Hamiltonian, a separable interaction is also present in the V-θ sector. This model, in the limit of vanishing wave function renormalization constant for the U particle, is shown to lead to results for the V-θ scattering amplitude and the renormalized UVθ coupling constant, which are identical to those obtained by Bronzan using an elementary U particle in the V-θ sector. No restriction is imposed thereby on the vertex renormalization constant. (auth)

15411 STATIONARY PHASE APPROXIMATION OF FEYNMAN PATH INTEGRALS. Lam, C. S. (McGill Univ., Montreal). Nuovo Cimento (10), 47A: 451-69(Feb. 1, 1967).

Feynman's path integral formalism is used to consider the transition matrix elements of a harmonic oscillator as perturbed by an anharmonic potential $\lambda(m\omega^2/4l^2)x^4$, and of a free field by a self-interaction $\lambda\varphi^4(x)$. It is argued that even in the weak coupling limit $|\lambda| \ll 1$, ordinary perturbation theory is not always valid because of the dominance of the perturbing interactions at large x and $\varphi(x)$ respectively. In the Feynman path integral formalism, it is possible to make use of the large parameter $1/\lambda$ to develop a stationary-phase approximation method valid for $|\lambda| \ll 1$. The result of this method is not the same as that of the usual perturbation method. The stationary-phase series consists of the ordinary perturbation series, but rearranged, plus a series of terms having a singularity at $\lambda = 0$. The origin of these terms with an essential singularity is discussed, and is shown to be unrelated to the origin of the divergence problem in quantum field theory, contrary to some expectations. It is however essentially due to the reason advanced by Dyson. An example of a one-dimensional integral which exhibits all these differences between the correct asymptotic series and the incorrect perturbation series is also discussed. (auth)

Scattering Theory

Refer also to abstracts 15248 and 15336.

15412 (ANL-7029, pp 25-7) ANALYSIS OF SCATTERING. Monahan, J. E.; Langsdorf, A. Jr. (Argonne National Lab., Ill.).

Criteria are described that enable an experimenter to select a set of angles at which an angular distribution should be measured in order that the resulting set of measurements should determine the distribution with minimum uncertainty. Criteria are also given for the selection of measurements that provide most sensitive tests of hypotheses about the degree of the distribution. These results are applicable to the measurement of any distribution that can be expressed as a polynomial of finite degree. (auth)

15413 (JINR-P2-3139) RASSEYANIE NA MALYE UGLY I NIZHNYAYA GRANITSA UBYVANIYA AMPLITUDY V OBLASTI BOL'SHIKH UGLOV. (Small-Angle Scattering and a Lower Bound for the Scattering Amplitude at Large Angles). Logunov, A. A.; Mestvirishvili, M. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 10p. (In Russian). Dep. mn.

A relation is established between the lower bound for the large-angle scattering amplitude and the behavior of the diffraction and of the backward scattering peak widths. (auth)

15414 (NYO-2262TA-146) ANALYTICITY PROPERTIES AND ASYMPTOTIC BEHAVIOR OF SCATTERING AMPLITUDE. Jin, Y. S. (Brown Univ., Providence, R. I. Dept. of Physics). Feb. 1967. Contract AT(30-1)-2262. 25p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Recent developments in the study of analyticity properties of the scattering amplitude in local field theory and some immediate applications of these properties in order to obtain asymptotic behavior are reviewed. Fixed dispersion relations and the Lehmann ellipse, an extension of the analyticity domain, and asymptotic behavior are considered. (J.F.P.)

15415 (UCRL-17250) RECENT WORK ON REGGE POLES AND THE THREE-BODY PROBLEM. Mandelstam, Stanley (California Univ., Berkeley. Lawrence Radiation Lab.). Nov. 7, 1966. Contract W-7405-eng-48. 37p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Three lectures are presented on recent work on Regge poles and the three-body problem. Topics discussed are the three-body N/D equations, features of Regge trajectories with three-particle and multiparticle intermediate states, and the asymptotic behavior of amplitudes for backward scattering. (B.G.D.)

15416 SOME ASPECTS OF COMPLEX ANGULAR MOMENTUM AND THREE-PARTICLE STATES. II. Drummond, Ian T. (Cambridge Univ., Eng.). Phys. Rev., 153: 1565-74(Jan. 25, 1967).

The discussion of the continuation of a three-particle unitarity integral to complex angular momentum is extended to the case where the production amplitudes depend on a subenergy. It is found that the prescription derived in a previous paper still applies, though only as the result of a cancellation occurring within the phase-space integral. (auth)

15417 OPTICAL POTENTIAL FOR HIGH-ENERGY PHYSICS: THEORY AND APPLICATIONS. Arnold, Richard C. (Argonne National Lab., Ill.). Phys. Rev., 153: 1523-46(Jan. 25, 1967).

A field-theoretic exact two-body optical potential V^0 is defined, corresponding to the exact pseudopotential in nuclear physics. A small-angle, high-energy approximation for scattering amplitudes in the absence of resonances or bound states is suggested, based largely on investigations of Torgerson in a fairly realistic model field theory. This approximation, which corresponds to the eikonal or linearized WKB approximation in a nonrelativistic limit, involves only mass-shell values of V^0 and can be discussed in the framework of dispersion relations and analyticity. The longest range contributions to V^0 are one-pion exchange (when allowed) and the multiperipheral diagrams of Amati, Fubini, and Stanghellini; these contributions are termed "multiperipheral optical potential" (MOP). One possibility for the asymptotic high-energy limit of MOP brings in Regge poles through the multiperipheral diagrams. At energies which are not asymptotic, but are high enough to ensure the usefulness of the eikonal formalism, important non-pole contributions to V^0 are discussed. The difference between $\bar{p}p$ and pp elastic scattering is explained in such an energy region. As a natural consequence of the picture presented, one obtains distorted-wave Born-approximation (DWBA) correction formulas applicable to any small contributions in V_0; e.g., real part, spin flip, and charge exchange. A special case is the absorptive correction to the ρ Regge-pole expression for charge exchange in $\pi^-p \to \pi^0n$, which has been discussed in a previous paper. The Serber potential which accommodates large-t behavior (although only $-t/s \ll 1$ can be properly described by the eikonal expression) is shown to be a special case of MOP. If MOP is dominated by the Pomeranchuk Regge pole (P) in elastic pp scattering above 10 BeV/c, and if is ignored spin, a real part of the forward scattering amplitude for this case is obtained, which agrees in sign with the observed value, but is too small in magnitude; it has an energy dependence

$[\ln s/s_0]^{-1}$. The $\bar{p}p$ results should become identical to the pp ones for energies which are asymptotic for $\bar{p}p$ also. Similar results for the real part hold for all two-body reactions. In πp scattering, a formalism incorporating spin properly into the eikonal method is presented, and in the asymptotic limit with no "anomalous-moment" terms in the Born approximation (as suggested by a Pomeranchuk pole), a spin-orbit coupling is obtained corresponding to use of the Dirac equation with a 4-vector static central potential. The resulting πp spin-flip amplitude decreases with increasing energy like $s^{-\frac{1}{2}}$ relative to nonflip terms, but is presumably dominated by effects of secondary Regge poles such as P'. To describe multichannel reactions, and to obtain absorptive correction formulas including reactive damping, an exact multichannel optical potential V_{ij}^0 is defined, and a matrix eikonal mass-shell approximation is proposed. Such a method is valid only when certain commutation relations are satisfied for the matrix Born approximation; these are satisfied, for example, if the t dependence of all elements of this matrix is the same, which can be true in many cases if mass differences are ignored. Regge poles and the Byers-Yang model are considered in this context. To include resonances in the s channel, possibilities for extending the eikonal formalism are discussed. A method of formulation utilizing dispersion relations for phase shifts allows an alternative, purely S-matrix approach to the eikonal approximation, but is physically more obscure than the field-theoretic and static-potential-theory approaches. Singularities in complex J of the MOP-eikonal approach are explored. It is found that infinite numbers of branch cuts in J correspond to absorptive (DWBA) corrections when Regge poles are used in MOP. An apparent paradox concerning results of Mandelstam on cancellation of cuts is discussed and a possible avenue of resolution, involving treating external particles as Regge poles with signature, is described. (auth)

15418 SPURIOUS SOLUTIONS OF THREE-PARTICLE EQUATIONS. Newton, Roger G. (Indiana Univ., Bloomington). Phys. Rev., 153: 1502(Jan. 25, 1967).

The origin of the spurious eigenvalues of Weinberg's kernel for three particles, discovered by Federbush in a special case, is discussed. They are shown to be generally expected with Weinberg's kernel because of its factorization property. Noble's contention that every complex energy is an eigenvalue of Weinberg's kernel is shown to be incorrect. (auth)

15419 CAUSALITY CONDITION ON THE MASS SHELL. Rzewuski, J. (Univ. of Wroclaw. Inst. of Low Temperature and Structural Research, Polish Academy of Sciences). Acta Phys. Pol., 31: 19-32(Jan. 1967).

A formulation of the principles of the S-matrix theory is attempted which contains the on mass shell S-matrix elements only. The basis for this formulation is the generating functional for the S-matrix elements. Classes of equivalent functionals which are equal on the mass shell are introduced and some examples are treated. The conditions of relativistic invariance and unitarity are formulated on mass shell. Two approaches to the problem of causality condition on mass shell are presented. (auth)

15420 PEREY EFFECT AND THE ANALYTIC PROPERTIES OF THE WAVE FUNCTION. Reading, J. F. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 153: 1377-8(Jan. 25, 1967).

The Perey effect is shown to be related to the analytic properties of the wave function, which are different for local and nonlocal potentials. (auth)

15421 COUNTING THE BOUND STATES FOR CENTRAL POTENTIALS. Swan, Peter (Laval Univ., Quebec). Phys. Rev., 153: 1379-84(Jan. 25, 1967).

An interaction potential is fitted by a multiple-step function, step width $\Delta R \to 0$, to yield a first-order differential equation for phase function $\eta_l(k,r)$, and also an integral for the wave-function amplitude $A_l(k,r)$. Both neutral- and charged-particle scattering is treated. The number of bound states follows by integration of the $\eta_l(0,r)$ equation and Levinson's theorem $\eta_l(0,\infty) = n_l\pi$; also, for $U'(r \geq R) \geq 0$, one has $|\psi_0(r \geq R)| \leq 1$. An approximate method of evaluating all the eigenenergies via scattering phase shifts is discussed. (auth)

15422 CLUSTER DECOMPOSITION AND THE SPIN-STATISTICS THEOREM IN S-MATRIX THEORY. Froissart, Marcel; Taylor, John R. (Princeton Univ., N. J.). Phys. Rev., 153: 1636-48(Jan. 25, 1967).

The connection between spin and statistics is established within S-matrix theory; namely, that the multiparticle-state vectors are symmetric or antisymmetric for permutation of identical particles according as the particle concerned has integral or half-integral spin. The proof given, which is simpler than previous S-matrix proofs, depends on the cluster-decomposition property, crossing symmetry, and Hermitian analyticity. A considerable part of the paper is concerned with establishing a suitable framework to formulate the first of these properties, cluster decomposition. To this end the idea of the tensor product $f \otimes g$ is developed from first principles, which, for any two state vectors f and g, represents the composite state (f and g). (auth)

15423 REGGE POLES AND UNEQUAL-MASS SCATTERING PROCESSES. Freedman, Daniel Z.; Wang, Jiunn-ming (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 153: 1596-1609(Jan. 25, 1967). (UCRL-17014).

It is not clear from the Regge representation that the asymptotic form $s^{\alpha(u)}$ holds in the backward scattering of unequal-mass particles, because the cosine of the u-channel scattering angle remains small as s increases. A representation for the scattering amplitude first suggested by Khuri is used to show that the form $s^{\alpha(u)}$ is valid throughout the backward region. However, in order to ensure the analyticity of the amplitude defined by the Khuri representation at u = 0, it is necessary that Regge trajectories occur in families whose zero-energy intercepts are spaced by integers. Denoting the leading or parent trajectory by $\alpha_0(u)$, it is found that daughter trajectories $\alpha_k(u)$ must exist, of signature $(-1)^k$ relative to the parent, satisfying $\alpha_k(0) = \alpha_0(0) - k$. Bethe–Salpeter models are then studied and it is found that this daughter-trajectory hypothesis is satisfied for any Bethe–Salpeter amplitude which Reggeizes in the first place. This fact follows elegantly from the four-dimensional symmetry of Bethe–Salpeter equations at zero total energy. Some phenomenological implications of the daughter-trajectory hypothesis are discussed. The behavior of partial-wave amplitudes in unequal-mass scattering at u = 0 was also characterized and the hitherto unsuspected result $a(u,l) \sim u^{-\alpha(l)}$ was found, where $\alpha(u)$ is the leading u-channel Regge trajectory. (auth)

15424 SCATTERING AND NONTRIVIAL COUPLING OF INTRINSIC AND SPACE-TIME SYMMETRIES. Formanek, J. (Czech Technical Univ., Prague). Czech. J. Phys., 17: 99-111(1967).

It is proved that the condition of invariance of physical laws under a group G, belonging to a wide class of groups which describe simultaneously space-time and intrinsic symmetries, restricts the S-matrix. Possible ways of avoiding this difficulty are briefly discussed. (auth)

15425 VALIDITY OF APPROXIMATE THREE-PARTICLE SCATTERING MODELS IN AN EXACTLY SOLUBLE THEORY. Choudhury, S. Rai (Moscow State Univ.). Nuovo Cimento (10), 47A: 349-54(Feb. 1, 1967).

The approximate equations proposed by Lovelace for three-body scattering problems are studied in the V-θ sector of the Lee model, with the view of testing the quantitative validity of the approximations involved. Comparison of the approximate with the exact solution shows that the two can generally differ considerably because the crossed N-pole comes out with a different residue in the approximate theory. This difference is narrowed but still can be considerable, if an arbitrary subtraction is performed at the crossed-pole position. It is concluded that the equations give a much too simplified version of the three-body problem. (auth)

15426 SINGULAR POTENTIALS AND MULTIPLICITY OF THE N/D SOLUTIONS. Clement, G.; Jacquemin, A. (Coll. de France, Paris). Nuovo Cimento (10), 47A: 589-608(Feb. 1, 1967). (In French).

The problem of deducing the s-wave elastic scattering amplitude from the left-hand discontinuity $\omega(s)$ is studied, both in nonrelativistic and relativistic formalism. The singular potentials considered here are defined by the asymptotic behavior of the function $\varphi(s) = (1/\pi)\int_L \omega(s')ds'/(s'-s-i\epsilon)$; they are such that the integral $\int_R (\rho(s)\varphi(s)/s)\,ds$ does not converge, and are further restricted to be attractive. It is shown by using a generalization of the BGKT method that one can construct an infinity of amplitudes satisfying the same unsubtracted dispersion relation and that if CDD poles are excluded, all these amplitudes also obey the same N/D system without free parameters. A direct study of the integral equation for N leads to the same conclusion. For potentials behaving like r^{-2} at short distances, it is shown how the manifold of amplitudes previously obtained can be related to the regular solutions of the radial Schroedinger equation. An interpretation in terms of a contact interaction with vanishing bare constant is presented. A parallel with the regular potential case shows the deep similarity between the two cases, but also emphasizes the difficulties which are encountered in the singular case. In conclusion the physical implications of this one-parameter ambiguity are briefly discussed. (auth)

15427 DOUBLE REGGE POLES AND REGGE CUTS. Osborne, P.; Polkinghorne, J. C. (Cambridge Univ., Eng.). Nuovo Cimento (10), 47A: 526-40(Feb. 1, 1967).

The effect of double Regge pole insertions in generating cuts is

investigated first in a perturbation theory model and then more generally in terms of the Froissart–Gribov continuation. It is found that they only generate cuts whose trajectories are identical with those associated with single Regge pole insertions. (auth)

15428 CLASS OF COMPLETELY TRANSPARENT NONLOCAL TWO-BODY POTENTIALS. Chadan, K. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nuovo Cimento (10), 47A: 510-25(Feb. 1, 1967).

The existence of a large class of nonlocal two-body potentials which are completely transparent at all energies is shown. These potentials are superpositions of a local central potential and a sum of separable potentials. Starting from an arbitrary local potential, it is shown how to choose the nonlocal separable parts in such a way that the effects of the local potential are canceled out at all energies and for all angular momenta. The total Hamiltonian therefore becomes equivalent to the free Hamiltonian as long as the S-matrix on the energy shell is concerned. At finite distances, the wave-function is of course different from the free wave-function, but the difference goes to zero in the limit of large distances. It is perhaps worth mentioning that the transparent potentials obtained are not pathological; they have acceptable singularities at the origin and vanish fast at infinity. In the example studied are indeed potentials which are less singular than r^{-1} at the origin, and decrease exponentially when $r \to \infty$. (auth)

15429 NOTE ON THE SYSTEMATICS OF MANY-PARTICLE SYSTEMS. Goldberg, H. (Univ. of Rochester, N. Y.). Nuovo Cimento (10), 47A: 495-509(Feb. 1, 1967). (UR-875-134).

The direct product of many irreducible representations of the Poincaré group is discussed. A procedure is suggested for the decomposition in the canonical scheme, which is not an iteration of the 2-particles method, as previously described. Also, it is independent of the cms. The corresponding expression for S-matrix elements of many-particle processes is given. The properties of the invariant functions associated with elastic scattering in case of parity, time reversal and crossing symmetries are discussed, as well as in case of identical particles. (auth)

Particle Accelerators

Refer also to abstract 14367.

15430 (ANL-7029, pp 13-14) INSTALLATION OF A 2-MeV VAN DE GRAAFF GENERATOR. Wallace, J. R.; Kaminsky, M. S. (Argonne National Lab., Ill.).

A surplus 2-MeV Van de Graaff generator was converted into a positive-ion accelerator. It will be used primarily, but not exclusively, in studies of the phenomena associated with ionic impact on solids. (auth)

15431 (ANL-7251) ENERGY-ANALYZING SYSTEM FOR THE ARGONNE 60-INCH CYCLOTRON. Ramler, W. J.; Livingood, J. J.; Parker, G. W.; Aron, J.; Oselka, M. C. (Argonne National Lab., Ill.). Oct. 1966. Contract W-31-109-eng-38. 58p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The extracted beam of ions from Argonne's 60-in. cyclotron, installed in 1952, has a total energy spread of about 1%. Increased sophistication of experiments within recent years has called for an analyzing system capable of reducing the spread to the lowest feasible value. The system of magnets, ancillary hardware, and the resulting dispersive and achromatic operation are discussed. An energy resolution (full width at half maximum, FWHM) of $\Delta E/E = 0.08\%$ was obtained for alphas of 43.2 MeV. (auth)

15432 (BNL-11034) SOME ASPECTS OF TARGETING SYSTEMS FOR A SLOW EXTRACTED BEAM AT THE AGS. Read, A. L. (Brookhaven National Lab., Upton, N. Y.). Jan. 30, 1967. Contract AT(30-2)-Gen-16. 10p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Some possible beam-handling arrangements at targeting stations for the slow extracted beam which is to be developed at the AGS are considered. Some problems are discussed relevant to production of secondary particle beams, which are peculiar to external proton beams, and have not been encountered during the use of the F-10 and G-10 internal target areas. (B.G.D.)

15433 (BNL-11041) THEORY OF LONGITUDINAL INSTABILITIES IN SYNCHROTRONS, WITH APPLICATIONS. Pease, Robert L. (Brookhaven National Lab., Upton, N. Y.). Dec. 16, 1966. Contract AT(30-2)-Gen-16. 24p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

By combining the results of longitudinal instability theory and synchrotron oscillation theory, it is possible to derive two simple and useful expressions for longitudinal instability particle threshold. The first, which holds at injection, is given directly in terms of design parameters; in practical cases it turns out to depend only slightly on injection energy and to be independent of field index and vacuum chamber size, provided only that the vacuum chamber is large enough to contain particle oscillations. The second, which is based on adiabatic bunch behavior, displays the variation of threshold with energy; it decreases monotonically from injection to transition (if a real transition exists) and then increases monotonically. Different regions of this universal curve are relevant, depending upon whether the machine considered is a booster, a weak-focussing machine or a standard AG synchrotron in which transition is crossed. Practically, it appears that recently proposed boosters will be free from longitudinal instabilities if a little care is exercised in design. It is quite evident that proposed improved AG machines will have no problems at injection; the treatment of the transition region is still crude, and further analysis will be required for a definite answer — it appears that there might be trouble at least in Phase II (2×10^{13} protons) unless the capture at injection is extremely efficient. (auth)

15434 (BNL-11047) ECONOMICAL POWERING OF A LARGE MULTIPLICITY OF SPUTTER-ION PUMPS. Carides, T.; Cottingham, J. G. (Brookhaven National Lab., Upton, N. Y.). [nd]. Contract AT(30-2)-Gen-16. 5p. (CONF-670307-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From National Particle Accelerator Conference, Washington, D. C.

The economic and technological aspects of separating the starting and holding power supply equipment for a large number (280 for AGS) of sputter-ion pumps used with accelerators are discussed. (B.G.D.)

15435 (BNL-11048) DESIGN STUDY OF A SUPERCONDUCTING RADIOFREQUENCY BEAM SEPARATOR. Hahn, H.; Halama, H. J. (Brookhaven National Lab., Upton, N. Y.). [1967]. Contract AT(30-2)-Gen-16. 7p. (CONF-670307-2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From National Particle Accelerator Conference, Washington, D. C.

A design study of a superconducting rf beam separator suitable for counter beams is presented. A simple two-deflector separation scheme permits one-contaminant rejection in momentum ranges from 8.5 to 19 GeV/c for p and π beams and from 4.5 to 10 GeV/c for K beams. The operating wavelength $\lambda = 24$ cm was obtained by optimizing the transmission of wanted particles. An interdeflector spacing of L = 33 m follows. The geometrical configuration of the lead-coated iris-loaded structure is selected for highest bandwidth which is obtained when the ratio of aperture radius and wavelength is close to 0.2. The maximum deflecting field in the 3 m long resonant ring deflector is limited to about 7 MV/m. The superconducting structure is expected to have a shunt impedance of $R \approx 10^{12}$ Ω/m and an unloaded quality factor of $Q_0 \approx 1.5 \times 10^9$. The ensuing rf power requirements are discussed. (auth)

15436 (BNL-11076) FOLDED FERRITE LOADED CAVITIES FOR IMPEDANCE MATCHING IN THE AGS. Plotkin, M. (Brookhaven National Lab., Upton, N. Y.). [nd]. Contract AT(30-2)-Gen-16. 5p. (CONF-670307-5). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From National Particle Accelerator Conference, Washington, D. C.

The AGS conversion requires twice the accelerating volts/turn and driving amplifiers removed from the ring to a central building. The accelerating cavities must be tuned over a frequency range of 2.5 to 4.5 MHz. In addition the number of accelerating positions will be reduced from twelve to eight. These specifications combine to place severe restrictions on the accelerating cavity structure. To minimize power losses in the cavity it is necessary that more ferrite be added. A method of folding the cavities in the radial direction yields a structure which not only raises the cavity impedance, but also enables matching to the input line without using a broad band transformer. A further desirable feature of the structure is the ability to place four gaps, rather than two, in each accelerating straight section thus halving the voltage per gap and halving the voltage on the input lines. A sample computation was made using currently available ferrite in sizes essentially the same as have been used at the AGS and PPA. The results look favorable and additional ferrites are being investigated to find higher μQf values. (auth)

15437 (CEA-R-3058) ETUDES DES CARACTERISTIQUES MAGNETIQUES DES FERRITES EN VUE DE LEUR APPLICATION DANS UN SYNCHROTRON A PROTONS. (Study of the Magnetic Characteristics of Ferrites With a View to Their Application in a Proton Synchrotron). Nguyen, Khanh Cung (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct. 1966. 108p. (In French). Dep. mn.

Thesis. Submitted to Univ., Paris.

The magnetic characteristics of seven types of ferrites were

measured systematically as a function of various physical parameters which affect them in the functioning of an accelerating cavity. These ferrites were chosen from the values of their initial permeability and their quality factor Q_1. From the results obtained it appears that four of the ferrites, as a function of the magnetic polarization variations, obey simpler laws than those of the other three. For a proton synchrotron operating from 15 to 30 MHz one of the ferrites studied, designated by F3, had the best characteristics for utilization in a proton synchrotron. This ferrite in the frequency range studied had constant initial permeability and quality factor. Moreover the variation of its permeability incrementally reversible by a factor of four can be obtained with the aid of a polarization field of the order of 5,000 amp/m. The parameters studied were the frequency, hf induction, the polarization magnetic field, and the temperature. (J.S.R.)

15438 (CEA-R-3068) CONSERVATION DE LA BRILLANCE D'UN FAISCEAU IONIQUE. ETUDE E'UNE LENTILLE NE DETERIORANT PAS CETTE BRILLANCE. (Conservation of an Ion Beam Brightness. Study of a Non Brightness Disturbing Lens). Bernard, Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov. 1966. 106p. (In French). Dep. mn.

Thesis.

Previous studies have shown that very great brightness can be obtained if the extraction and focusing systems are conceived so that they carry no aberrations. This concept was used in the design of a lens system that would not disturb the brightness of an ion beam. The principal elements of the assembly are described with emphasis on the elements essential for success. The experimental results obtained show that the methods of calculation used and the concept of linearity make it possible to define and construct a lens focusing a high intensity beam without multiple loss of brightness. (J.S.R.)

15439 (CONF-660221-, pp 312-15) THREE PORT HOLE BEAM SWITCHING MAGNET. Raheja, U. T.; Kondaiah, E. (Tata Inst. of Fundamental Research, Bombay (India)); David, T. P.; Bhalerao, P. J. (Atomic Energy Establishment, Trombay (India)).

A three port hole beam switching magnet for a Van de Graaff accelerator is described. The magnet which produces fields up to 12 kG is fitted with six coils connected in series and designed for continuous operation with normal air cooling at room temperature. (B.G.D.)

15440 (CONF-660221-, pp 326-9) DEVELOPMENTS IN THE ION BEAM HANDLING FACILITIES AT THE VAN DE GRAAFF ACCELERATOR. David, T. P.; Bhatia, M.; Thampi, N. S.; Bhat, G. V.; Kulkarni, R. P.; Sarma, N. (Atomic Energy Establishment, Trombay (India)).

A magnetic quadrupole lens was designed and constructed based on a paper by W. Weidman (Nucl. Inst. and Methods 9, 347(1960)). The system used is a combination of two such lenses phases by 90°, to obtain focusing in both x and y planes. (B.G.D.)

15441 (IS-1270) A COMPUTER-BASED MULTIPARAMETER ANALYZER. Frederick, David E. (Ames Lab., Iowa); Marshall, T. (Scientific Data Systems, Los Angeles, Calif.). Nov. 2, 1965. Contract W-7405-eng-42. 23p. (CONF-651001-10). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From IEEE Nuclear Science Symposium, San Francisco.

computers; instrumentation; particle accelerators 09B, 18D, 20G

A system has been constructed and used for on-line acquisition of data at the Iowa State Synchrotron Laboratory. The principal components include eight Victoreen analog-to-digital converters (ADC) and a fast general purpose digital computer (SDS 910) along with the necessary interface circuitry to couple to the digitized outputs of scalers, clocks, etc. Although quite flexible in application, the ADC-to-computer interface was designed especially for efficient use (minimum deadtime and bias) both with an accelerator having a beam burst of about 100 microseconds duration and for continuous operation. To minimize ADC deadtime in either circumstance, each 8Mc/sec ADC, equipped with an analog buffer, is connected through a plugboard to a digital buffer register synchronized to the ADC. This permits readout of the digitized pulse heights in less than one microsecond. In experiments where the ADC's operate completely independently of one another, a hardware option is provided to interpret the buffer register contents as addresses in the computer memory. This option eliminates the necessity for software programming of data input: the contents of the associated word in memory may be either incremented or decremented automatically in a minimum of two computer cycles. Some biasing in efficiency normally occurs in multiple ADC systems at high counting rates when two or more registers are waiting for readout. To reduce such bias to a negligible amount, logic governing data transfer to the computer sequences through a hierarchy of register preferences with a periodicity of 128 microseconds. The use of the plugboard for event tagging by time or type is also discussed. (auth)

15442 (SC-CR-66-158) ELECTRON BEAM MAPPING STUDIES ON THE 4 Mv FACILITY. Graybill, S. E.; Nablo, S. V. (Ion Physics Corp., Burlington, Mass.). Feb. 1967. Contract AT(29-1)-789; Subcontract 18-4300. 44p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For Sandia Corp., Livermore, Calif.

A brief description of the IPC four megavolt pulsed electron accelerator (FX-1) is presented. Techniques which were developed for the study of the self-focused relativistic stream from the system are reviewed along with a description of the fixed field magnetic spectrometer used in the determination of the beam spectral characteristics at the entrance plane. The use of these diagnostic techniques in the mapping of streams from FX-1 at terminal potentials of 1.55 to 3.45 MV. is then described. Current density profiles and spectral data for varying stream conditions are presented under the following range of beam parameters: $0.88 \leq E \leq 2.20$ MeV and $8600 \leq I \leq 23{,}000$ amperes. A discussion of these results follows and their reproducibility, for the purpose of further applications, is discussed. (auth)

15443 (SLAC-PUB-246) DESIGN OF LOW-BETA INSERTIONS FOR STORAGE RINGS. Morton, P. L.; Rees, J. R. (Stanford Linear Accelerator Center, Stanford Univ., Calif.). Dec. 1966. Contract AT(04-3)-400. 5p. (CONF-670307-4). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From National Particle Accelerator Conference, Washington, D. C.

A design technique is presented which separates the problem of producing a small beam size at the interaction region from that of not disturbing the equilibrium orbits of off-momentum particles outside the insertion. It may be used to produce desired values of β_x and β_y in the middle of the insertion where $\eta = 0$. The same technique is applicable to the design of synchrotron sections with specially chosen beam properties. (auth)

15444 MANUFACTURE OF VACUUM VESSELS FOR THE NINA SYNCHROTRON. Hart, C. J. (English Electric Co., Luton, Eng.). Nucl. Eng., 12: 115-7(Feb. 1967).

The beam is accelerated in 40 curved vessels each 13 ft long fabricated from extruded stainless steel and titanium alloy strips. The metals are bonded together and wrapped using a hot-setting epoxy resin and glass fiber laminate. The workshop techniques and quality control procedures are described. (UK)

15445 USE OF HIGH-FREQUENCY FIELDS FOR FOCUSING PARTICLES IN CYCLIC ACCELERATORS. Didenko, A. N.; Fomenko, G. P. Zh. Tekh. Fiz., 36: 1560-8(Sept. 1966). (In Russian).

The focusing by high-frequency electromagnetic fields of charged particles moving in a toroidal track of circular or rectangular cross section is discussed. It is shown that strong focusing can be achieved in a weak-focusing accelerator with the aid of either traveling or standing waves. Conditions for the stability of the motion and expressions for the strength of the focusing are derived. For strong focusing, the high frequency magnetic field must be stronger than the dc guiding field, and focusing is most readily achieved with traveling waves propagating in the direction opposite to that of the motion of the particles. In the calculations for the toroidal track with circular section it was assumed that the high frequency field has the same form as in a straight waveguide of circular section. The equations of motion of a particle in the presence of TE waves reduce for zero wave frequency to those for a particle moving in a p-fold helical field (p is an integral parameter) and, for the values of 2 and 3 of p, to the equations of motion obtained by V. S. Zakharov and M. S. Rabinovich (ZhTF 34, 1986, 1992, 1964) for a charged particle in a double or triple helical field. In the case of a toroidal track of rectangular cross section the high frequency fields in a straight waveguide cannot be employed in the calculations because the curvature of the track lifts the degeneracy of the TE and TM modes. For the rectangular cross section calculations the field is expanded in LE and LM waves, and results analogous to those for the circular cross section case are obtained. In all these calculations it is assumed that the component of the velocity of the particle in the direction of the track is constant. In a final section a criterion for the validity of that assumption is derived and an integral of motion is obtained with the aid of which corrections can be calculated in case the criterion is not met. (ATD)

15446 SINGLE-REVOLUTION INJECTION SYSTEM OF THE BSB IRON-FREE SYNCHROTRON. Mostovoi, Yu. A.; Samoilov, I. M.; Sokolov, A. A. Zh. Tekh. Fiz., 36: 1550-9(Sept. 1966). (In Russian).

The injection system employed in the BSB iron-free electron synchrotron is described. In this machine injection is accomplished during a single revolution of the electrons in the 41 cm radius or-

bit. Single-revolution injection was adopted because the efficiency of many-revolution injection is low in small machines in which the decrease per revolution of the radius of the instantaneous orbit is small. With single-revolution injection, on the other hand, it is in principle possible to capture practically 100% of the injected particles and to reduce the amplitude of the residual betatron oscillations to zero by proper design and positioning of the inflector. The conditions to be satisfied by the inflector for maximum capture efficiency are derived in an appendix; one such condition is that the trajectory of the injected particles in the absence of the inflector be tangent to the equilibrium orbit at the center of the inflector. In the present machine the inflector is excited by up to 50 kV square pulses of 5 microsec duration applied through a pulse transformer. At the close of the 10 nanosec injection period the inflector is short circuited by the breakdown of two gaps, the breakdown being initiated by a trigger pulse applied to a third electrode in each gap. The design of these gaps, which should be useful for other applications, is discussed in detail in an appendix. The scatter in the breakdown time of these gaps ranged from 2 nanosec to less than 1 nanosec, depending on the height of the trigger pulse. Measurements on a 70 keV injected beam showed that at least 70% of the injected electrons were captured in an equilibrium orbit and that the amplitude of the betatron oscillations of 50% of the captured electrons was less than 2 cm. Analogous measurements at the operating injection energy of 600 keV could not be made because of noise from the injector. It is concluded that single-revolution injection is entirely feasible for accelerators in which the period of the equilibrium orbit is as short as 5 nanosec. (ATD)

15447 MAGNET POWER SUPPLY FOR THE BSB IRON-FREE SYNCHROTRON. Livshits, A. A.; Nelidov, A. B.; Samoilov, I. M.; Sokolov, A. A. Zh. Tekh. Fiz., 36: 1544-9(Sept. 1966). (In Russian).

The power supply for the magnet of the BSB single turn iron-free electron synchrotron is described. The main power supply is a 5 kV 0.045 F capacitor bank coupled to the single turn synchrotron magnet with a pulse transformer that steps the current up by a factor of 10. The pulse transformer consists of a 40 turn primary and a 4 turn secondary of heavy copper strip on a 600 cm^2 cross section ring-shaped rectangular core of transformer steel sheets. Design features of the pulse transformer that enable it to withstand the electrodynamic forces incident to supplying a secondary current of up to 10^6 A are discussed. The pulse transformer operates with superposed magnetization, which is provided by discharge through the primary of an auxiliary capacitor bank prior to the discharge of the main capacitors. The time dependence of the magnet current required for synchrotron operation is achieved with the aid of an auxiliary supply containing one or two capacitor banks, which are discharged at appropriate times prior to discharge of the main capacitor bank. Two successful variants of the auxiliary supply are described. The duration of the operating pulse is 1.8 millisec. The described supply operates at the rate of one pulse every 30 sec; the pulse rate could be increased by a factor of 10 by employing larger rectifiers for charging the capacitors and providing appropriate cooling. (ATD)

15448 CHARACTERISTICS OF THE MAGNETIC FIELD OF THE BSB IRON-FREE SYNCHROTRON. Nelidov, A. B.; Samoilov, I. M.; Sokolov, A. A. Zh. Tekh. Fiz., 36: 1536-43(Sept. 1966). (In Russian).

The magnetic field configuration of the BSB iron-free single turn synchrotron described elsewhere by G. I. Budker et. al. (ZhTF 36, 1523 (1966)) was explored by exciting the magnet with sinusoidal current pulses having rise times of the order of 10^{-3} sec and measuring the field components at different locations with the aid of pickup coils and electronic integrators. The effect on the field configuration of introducing foreign objects (such as copper plates) into the working region was investigated. Some of the field measurements are presented graphically, and possible reasons for the observed field distortions are discussed. The index describing the radial dependence of the field strength was found to be close to the design value of 0.4 throughout a region whose axial extent is nearly half the height of the chamber, and the field distortions were found to be such as to shift the beam by some 3 to 5 mm. It is concluded that the internal equipment required for synchrotron operation (the accelerating resonator, measuring equipment, and the like) can be so designed as to produce no appreciable additional distortion of the field. (ATD)

15449 THE BSB IRON-FREE SINGLE TURN SYNCHROTRON. Budker, G. I.; Medvedev, P. I.; Mostovoi, Yu. A.; Nezhevenko, O. A.; Nelidov, A. B.; Ostreiko, G. N.; Panasyuk, V. S.; Samoilov, I. M.; Sokolov, A. A. Zh. Tekh. Fiz., 36: 1523-35 (Sept. 1966). (In Russian).

The type BSB iron-free single turn synchrotron developed for injection of up to 180-MeV electrons into a storage ring is described. A general description of the machine was given elsewhere by Ye. A. Abramyan et. al. (Transactions of the International Conference on Accelerators, Dubna, 1963, p.1065, Atomizdat, M., 1964). Certain features of the accelerator are described, including the magnet, the magnet power supply, the injector, and the adjustment of the machine. The magnet winding consists of two concentric duralumin rings between which the beam circulates. The outer ring is capable of withstanding a magnetic pressure of 50 atm, and the geometry is such that the inner ring is in equilibrium under the magnetic forces, being subjected only to a hydrostatic pressure. The magnet is powered by a 0.045 F capacitor bank charged to 10 kV. The maximum magnet current is about 10^6 A, corresponding to an electron energy of 180 MeV. There are two auxiliary capacitor banks which are discharged at selected phases of the cycle to control the time dependence of the magnetic field. Injection of 600-kV electrons is accomplished during a single revolution of the captured electrons. The discharge of the auxiliary and main capacitor banks is so timed that the field is approximately constant during injection. The rf accelerating voltage is frequency modulated from 103.5 to 116 MHz, and is applied to the beam with the aid of a single resonator with a Q of 290. Some difficulties were encountered in the adjustment of the machine, but none that could not be overcome. It was possible to inject about 1.2 A of 600-kV electrons into the approximately constant field, and to accelerate some 20% of the injected electrons. The maximum beam current was found to be limited by longitudinal space charge effects (the negative mass effect), rather than by transverse space charge effects. It is suggested that higher currents might be achieved with a strong focusing iron-free pulsed machine. (ATD)

15450 MEASUREMENTS OF THE RESONANT FREQUENCY AND Q-VALUE OF THE MODEL CAVITY RESONATOR OF I.P.C.R. 1.6M CYCLOTRON. Fujisawa, Takashi; Odera, Masatoshi (Inst. of Physical and Chemical Research, Tokyo). Rika Gaku Kenkyusho Hokoku, 42: No. 2, 27-37(Mar. 1966). (In Japanese).

A ½ model was constructed of the cavity resonator of the I. P. C. R. (Rikagaku Kenkyusho) 1.6 m cyclotron, to ascertain the agreement between the measured and the theoretical value of the resonant frequency and of Q, to investigate the measuring techniques, and to find the factors influencing the Q-value. The measured value of the resonant frequency and of Q agreed with the theoretical value within 5 and 20%, respectively. Two methods were used for the measurement of the resonant frequency and Q-value. The attenuation curve method employing a square-wave interrupted hf oscillation was found to be satisfactory in the respects of the easy operation, stability, and availability of the required instruments. Electric circuits of the instruments and the data obtained are also given. (NSA of Japan)

15451 CORRECTION OF SPHERICAL ABERRATION OF AXIALLY SYMMETRICAL MAGNETIC LENSES. Marton, L. (National Bureau of Standards, Washington, D. C.). Rev. Sci. Instrum., 38: 130-1(Jan. 1967).

The correction of spherical aberration of axially symmetrical magnetic lenses by means of a diamagnetic element, i.e., superconductors, is discussed. This basic idea of correction is best illustrated by renouncing the condition of paraxial image formation, and adopting deliberately a geometry which conserves axial symmetry and uses the off axis regions of the lens. (B.G.D.)

15452 ELECTRON BEAM EXTRACTION FROM INS AG SYNCHROTRON. PART I. THEORY. Kawasaki, Sunao; Huke, Kazuo (Tokyo Univ.). Jap. J. Appl. Phys., 6: 231-41(Feb. 1967).

The theoretical basis for the electron beam extraction from the INS 0.75 GeV AG synchrotron is given. The method is essentially a Piccioni scheme in which the beryllium absorber target and two cascade kicker magnets are used. The extraction efficiency is calculated from the properties of the accelerated beam of the accelerator, the energy and angular distribution of the particles after passing through the absorber and the characteristics of betatron oscillations of the electrons in the guide field containing two pulse magnetic fields and the fringing field of the synchrotron magnet. The efficiency is found to be about 40% at most. (auth)

15453 ELECTRON BEAM EXTRACTION FROM INS AG SYNCHROTRON. PART II. EXPERIMENT. Huke, Kazuo (Tokyo Univ.); Kawasaki, Sunao; Yamakawa, Tatsuya; Yamaguchi, Seitaro; Fukunaga, Kiyoji; Kokame, Jun; Yamashita, Sukeaki; Yanabu, Takuji. Jap. J. Appl. Phys., 6: 242-50(Feb. 1967).

The electron beam was extracted from the INS 750 MeV AG synchrotron. A Piccioni scheme was applied and the extraction efficiency obtained was 10% at the electron energy of 540 MeV and 5% at 700 MeV. The behavior of the beam inside and outside of the synchrotron was studied in comparison with the theoretical analysis. The pulse duration of the extracted beam could be extended to the order of 700 μs without any difficulty for the 21.5 cps operation of the synchrotron. (auth)

15454 OBTAINING OF RESONANCE FREQUENCIES OF RADIAL OSCILLATIONS IN RELATIVISTIC CYCLOTRONS. Dmitrievskii, V. P.; Kolga, V. V.; Polumordvinova, N. I. (Joint Inst. for Nuclear Research, Dubna, USSR). 17p. (In Russian). (CONF-660510-1). DTIE. Gmelin, AED-CONF-66-112-16.

From International Conference on Isochronous Cyclotrons, Gatlinburg, Tenn.

A method is described of varying the radial oscillation frequency in a relativistic cyclotron by introducing a harmonic order N/2 into the magnetic field structure. It is shown that when the 4th harmonics is introduced at the limit radius, the amplitude being 4% of the value of the average field, into the magnetic field structure of the 700 MeV relativistic cyclotron, the frequency of radial oscillations increases from 1.8 up to 2.0. (auth)

15455 ORSAY ISOCHRONOUS CYCLOTRON CEVIL; PROGRESS AND STATUS, JANUARY 1966. Cabrespine, A. (Nuclear Physics Inst., Orsay, France). 4p. (CONF-660510-22). DTIE. Gmelin, AED-CONF-66-112-14.

From International Conference on Isochronous Cyclotrons, Gatlinburg, Tenn.

The characteristics of the Orsay isochronous cyclotron (CEVIL) are discussed. Topics included are heavy ion accelerator, use of metals with various permeabilities and damping gaps, self-oscillating rf generator, ion source, injector, and extraction. The research programs and beam characteristics are also discussed. (B.G.D.)

15456 USE OF SATURATED CHOKE COIL IN MAGNET CURRENT CIRCUIT. Bothe, W. (Deutsches Elektronen-Synchrotron, Hamburg). 4p. (In German). (CONF-660104-5). DTIE. Gmelin, AED-CONF-66-174-15.

From Symposium on Magnet Flat Topping for Rapid Cycling Particle Accelerators, Princeton, N. J.

The use of the saturated choke coil in the magnet current circuit is proposed in order to deflect for a short time the magnet current from the sinusoidal form and to maintain it constant. The effect of the saturated choke coil is calculated and its specifications are given. (J.S.R.)

15457 CHOKE COIL FOR THE MAGNET CURRENT SUPPLY (AIR COIL WITH IRON GROUND). Bothe, W. (Deutsches Elektronen-Synchrotron, Hamburg). 8p. (In German). (CONF-660104-6). DTIE. Gmelin, AED-CONF-66-174-14.

From Symposium on Magnet Flat Topping for Rapid Cycling Particle Accelerators, Princeton, N. J.

Specifications for the additions and modifications to the choke coil for the magnet current supply described in DESY-B 2.39 are given. (J.S.R.)

15458 REDUCTION OF THE ENERGY SCATTERING AT THE END OF THE ACCELERATION PROCESS. Steffen, K. G. (Deutsches Elektronen-Synchrotron, Hamburg). 9p. (In German). (CONF-660104-7). DTIE. Gmelin, AED-CONF-66-174-11.

From Symposium on Magnet Flat Topping for Rapid Cycling Particle Accelerators, Princeton, N. J.

A method is presented for the reduction of the energy scattering at the end of the acceleration process. The method is based on superposing a short sine wave on the magnetic current by means of an oscillation current over a pulse transformer. The primary circuit is given. The principles of the method are discussed in some detail. (J.S.R.)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 14441, 14452, 15227, 15231, 15565, and 15599.

15459 (ANL-7221) SNARG-1D: A ONE-DIMENSIONAL, DISCRETE-ORDINATE, TRANSPORT-THEORY PROGRAM FOR THE CDC-3600. Duffy, G. J.; Greenspan, H.; Sparck, S. D.; Zapatka, J. V.; Butler, M. K. (Argonne National Lab., Ill.). June 1966. Contract W-31-109-eng-38. 61p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The computer program SNARG-1D, which is based on the S_n discrete-ordinates method and is written for the solution of one-dimensional problems using the order n = 2, 4, 6, 8, 10, 12, 16, or 32, is described. The program is applicable to plane, cylindrical, and spherical geometries. The real or adjoint solution can be calculated, and homogeneous (eigenvalue) or inhomogeneous (external source) problems can be solved. (D.C.W.)

15460 (CEA-R-3038) SPECTROMETRIE DES NEUTRONS DANS UN MASSIF D'URANIUM NATUREL AU MOYEN DE LA REACTION $^6Li(n,t)^4He$ A L'AIDE DE DETECTEURS A BARRIERE DE SURFACE. (Neutron Spectrometry in a Natural Uranium Slab Using the $^6Li(n,t)^4He$ Reaction and Surface Barrier Detectors). De Leeuw-Gierts, Ghislaine; De Leeuw, Seraphin (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Oct. 1966. 32p. (In French). Dep. mn.

The advantage of using neutron spectrometry based on the energy distributions of the tritons produced by the reaction $^6Li(n,t)^4He$ has already been stressed in previous publications. The data are presented from two series of measurements carried out on a natural uranium slab. The stability and the reproducibility of E_t distribution measurements have been verified. In the second series the background noise was eliminated. Preliminary treatment of the data has made it possible to define the energy range analyzed; it covers the whole field of low energies. (auth)

15461 (CONF-660221-, pp 69-73) MEASUREMENT OF NONELASTIC CROSS SECTIONS OF NUCLEI FOR FAST NEUTRONS. Chatterjee, Arun; Ghose, A. M. (Bose Inst., Calcutta (India)).

A method is described by which the nonelastic cross sections of nuclei for fast neutrons can be measured without requiring the knowledge of any other cross sections. Some results for 14.8-MeV neutrons on Al, Sb, Cd, C, Ce, Cu, Pb, O, and W are presented. (D.C.W.)

15462 (CONF-660221-, pp 268-72) MEASUREMENT OF NEUTRON SPECTRUM BY TRANSMISSION METHOD. Ramakrishna, D. V. S.; Navalkar, M. P. (Atomic Energy Establishment, Trombay (India)).

A method for measuring the neutron spectra in reactors is outlined. A collimated beam of neutrons emerging from the reactor is passed through a V^{-1} absorber. The ratio between the neutron densities with and without the absorber is measured as a function of its thickness, and the spectrum is determined from this transmission data. The results of some experiments at the beam holes of the Apsara and CIR reactors are summarized. (D.C.W.)

15463 (CONF-660221-, pp 291-5) NEUTRON THERMALISATION IN LATTICES: PROGRAM THERMNIL. Jain, V. K.; Lawande, S. V. (Atomic Energy Establishment, Trombay (India)).

A method for calculating thermal neutron flux distributions as functions of energy and a single spatial coordinate is outlined. A computer program, THERMNIL, which incorporates the method, is briefly described. (D.C.W.)

15464 (CONF-660221-, pp 296-9) THERMAL NEUTRON SPECTRA IN REACTOR LATTICES: PROGRAM LATSP. Lawande, S. V. (Atomic Energy Establishment, Trombay (India)).

The theoretical formalism for a computer program LATSP, which can be used to calculate thermal-neutron spectra in reactor lattices, is outlined. (D.C.W.)

15465 (CONF-660221-, pp 300-2) MULTIPLE COLLISION PROBABILITIES IN THIN SLABS. Sahni, D. C. (Atomic Energy Establishment, Trombay (India)).

The dependence of multiple collision probabilities on the incident neutron angular distribution in plane geometry was investigated. Calculations were made for slabs with thicknesses of 0.005 to 2 mean free path. The flux distribution and the absorption, reflection, and transmission coefficients were obtained. (D.C.W.)

15466 (GA-7309) MEASUREMENT OF NEUTRON SPECTRA IN LIQUID HYDROGEN. Final Report. Trimble, G. D.; Houghton, G. K.; Profio, A. E. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). July 17, 1966. Contract NAS3-6217. 242p. (NASA-CR-72143).

Differential angular flux spectra of fast, intermediate, and thermal neutrons in liquid hydrogen were measured and were compared with the predictions of the one-dimensional transport theory code GAPLSN. The angular flux spectra were measured in a simple two-dimensional geometry represented by a cylindrical cryostat of liquid hydrogen with a small spherical isotropic fission source located externally on the axis of the cylinder. (D.C.W.)

15467 (N-66-37044) IMPROVED ANALYSIS OF SPHERE TRANSMISSION EXPERIMENTS FOR AVERAGE CAPTURE CROSS SECTIONS. Bogart, Donald (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). 1966. 17p. (NASA-TM-X-52235; CONF-661014-41). CFSTI $3.00 cy, $0.65 mn.

From IAEA Conference on Nuclear Data, Paris, France.

Monte Carlo calculations that account directly for energy-dependent cross sections and multiple-scattering processes in the sphere experiments provided significantly larger values of capture cross sections $\bar{\sigma}_C$ as a result of including effects of resonance scattering. The consequences are particularly important for Au, for which interpretation of the same experiments provides a value of $\bar{\sigma}_C$ at 24 keV of 635 ± 60 mb by Bethe analysis with a resonance self-shielding correction. The problem in applying the Bethe method when microscopic cross sections are energy-dependent may be reduced to the determination of an effective scattering cross section. By comparing values of average capture cross sections obtained from the Monte Carlo analyses with values obtained from the Bethe analyses for Ag, Sb, I, and Au, a suitable criterion was obtained. The use of the potential scattering cross section in the Bethe analysis was shown to provide results that were in reasonable agreement with the Monte Carlo results without the necessity for applying resonance self-shielding corrections. (auth)

15468 (ORNL-TM-1741) FIRST-ORDER PERTURBATION THEORY AS USED IN THE MULTIGROUP DIFFUSION CODE EXTERMINATOR-2. Tobias, Melvin; Fowler, T. B.; Vondy, D. R. (Oak Ridge National Lab., Tenn.). Jan. 10, 1967. Contract W-7405-eng-26. 13p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The application of first-order perturbation theory in the EXTERMINATOR-2 code is discussed. The program can be used to calculate the fractional change in multiplication constant per unit change in a macroscopic material constant or per unit change in a specified nuclide density. The equations used are briefly described. The results of test calculations are presented which compare the predictions of perturbation theory with computed Δk values produced by various input parameter changes. (auth)

15469 (WAPD-TM-627) MEASUREMENT OF THE EFFECTIVE RESONANCE INTEGRAL AND DOPPLER COEFFICIENT OF THORIUM OXIDE RODS. Palowitch, B. L.; Hardy, J. Jr. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Dec. 1966. Contract AT(11-1)-Gen-14. 47p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The effective resonance capture integral of ThO_2 was measured, at temperatures of 300 and 1200°K, for rods ranging in diameter from 0.4 to 3.0 cm. Calculated resonance integrals obtained using current cross sections and calculational methods are found to be in good agreement with the experimental results. (auth)

15470 AVERAGE AND EFFECTIVE ENERGIES, FLUENCE-DOSE CONVERSION FACTORS AND QUALITY FACTORS OF THE NEUTRON SPECTRA OF SOME (α,n) SOURCES. Nachtigall, D. (Kernforschungsanlage, Juelich, Ger.). Health Phys., 13: 213-19 (Feb. 1967).

Quantities of interest in the use of (α,n) sources are discussed. These sources comprise mainly Ra, Po, Pu, and Am as alpha emitters, with beryllium as the target material. (UK)

15471 TECHNIQUE TO DETERMINE SLOW NEUTRON SPECTRA FROM FOIL ACTIVATIONS. Fulmer, R. H.; Ruane, T. F. (Knolls Atomic Power Lab., Schenectady, N. Y.). Nucl. Appl., 3: 191-8(Mar. 1967). (KAPL-P-3141).

A method of determining slow neutron spectra from foil activations is described. Two sets of activants are irradiated. One set is composed of nuclides each of which has only one predominant resonance in the few eV region (resonance set); the other is com-

posed of nuclides which, as a group, present a variety of absorption cross sections for neutrons in the subcadmium energy range (subcadmium set). For reliability of analysis and insensitivity to experimental uncertainties, a suitable form for the neutron spectrum is found to be basically a Maxwellian plus 1/E form with variable parameters. The spectrum is written as $\phi(E) = GE \cdot \exp(-E/E_0) + KE^{-(1-b)} \cdot [1 - \exp(-E^2/c)]$, where K and b are parameters obtained directly from the absorption rates of the cadmium-covered resonance detectors. The remaining spectral parameters G, E_0, and c are chosen to produce a spectrum from which are computed absorption rates of the irradiated foils in the subcadmium set. Values of G, E_0, and c are varied until the computed absorption rates give a least-squares fit to the measured absorption rates. The activation method was applied in two reactor cores. The predicted spectra are compared with corresponding spectra calculated by SWAK and SWAKRAUM. There is reasonably good agreement between the spectra predicted by experiment and calculation. (auth)

15472 DETERMINATION OF DIFFUSION COEFFICIENT OF THERMAL NEUTRONS BY NEUTRON WAVE TECHNIQUE. Islam, A. B. M. Nurul (NGFF Power Station, Fenchuganj, Sylhet, Pakistan). Nucleus (Lahore), 3: No. 1-2, 19-24(Jan.-June 1966).

A measurement of the diffusion constant for thermal neutrons in graphite is summarized. The effect of an empty channel in a unit cell of the graphite on the diffusion constant was investigated. The theoretical bases of the neutron-wave technique are outlined. (D.C.W.)

15473 TRANSIENT NEUTRON SPECTRA AND THE SLOWING DOWN RELAXATION TIME IN BERYLLIUM. Grover, P. S.; Kothari, L. S. (Univ. of Delhi). J. Nucl. Energy, Pt. A and B, 20: 835-48(Oct. 1966).

The Boltzmann equation in the diffusion approximation was numerically solved by the time-step method to determine transient neutron spectra, following a burst of fast neutrons inside beryllium assemblies of various sizes. Such a study also gives information about the decay constant of the fundamental mode and the slowing down relaxation time. It was found that for $B^2 < 4.0 \times 10^{-2}$ cm^{-2}, the decay constant as well as the neutron energy distribution at long times agrees well with the corresponding quantities calculated by an iteration procedure. However, for larger B^2, up to the time investigated (600 μsec after the initial burst) equilibrium is not established. Time-dependent neutron spectra were compared with the measurements of Gaerttner et al. The slowing down relaxation time for an infinite assembly comes out to be 114 μsec. This result is compared with the measurements of Zhezherun et al. who report a considerably higher value: 185 ± 20 μsec. The possible causes of this difference are discussed. (auth)

15474 MEASUREMENT OF THE NEUTRON DIFFUSION PARAMETERS OF WATER AT DIFFERENT TEMPERATURES BY THE PULSED METHOD. McClure, John Arthur. Blacksburg, Va., Virginia Polytechnic Inst., 1963. 81p.

Thesis.

The neutron diffusion parameters of water and ice were measured by the pulsed source method at 1.0°C and –19°C. Neutron pulses were obtained at one millisecond intervals by modulating the beam in a Cockcroft-Walton type accelerator. The $_1H^3(d,n)_2He^4$ reaction was used to generate neutrons. The samples were contained in cylindrical aluminum cans covered with cadmium. The experiment was conducted inside a large paraffin block which served as a neutron shield and thermal insulator. The temperature of the samples was maintained constant to within ±1°C. Neutrons leaving one surface of the sample were counted in a BF_3 proportional counter. The time distribution of these neutrons was recorded by an eighteen channel time analyser. The width of each channel was 20 microseconds. The opening of the first channel was delayed 100 microseconds with respect to the start of the neutron burst to minimize harmonics in the neutron decay. A geometric buckling B^2 was calculated for each sized sample. The measured decay constants, α, were fitted by the method of least squares to a polynomial in B^2. (Diss. Abstr.)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstract 15618.

15475 (CONF-660221–, pp 123-6) ELASTIC SCATTERING OF ALPHA PARTICLES FROM ^{6}Li. Sathe, D. K. (Tata Inst. of Fundamental Research, Bombay (India)); Nambiar, K. B.; Divatia, A. S.; Mehta, M. K. (Atomic Energy Establishment, Trombay (India)).

Excitation functions for alpha elastic scattering by ^{6}Li at 2.4 to 4.5 MeV were measured at laboratory angles of 56 and 80°. Spectra were also measured. Resonances corresponding to levels in the compound nucleus ^{11}B at 5.93, 6.06, 6.18, 6.31, 6.57, and 7.05 MeV were observed. The level at 6.31 MeV was previously unreported. Evidence of a level in ^{10}B at 6.81 MeV was also obtained. (D.C.W.)

15476 (CONF-660221–, pp 156-60) INTEGRATED CROSS SECTION OF HELIUM WITH A VELOCITY-DEPENDENT POTENTIAL. Srivastava, B. K.; Jain, S. C. (Allahabad Univ. (India)).

The integrated cross section is calculated assuming that the two-body forces are central but velocity-dependent. The static part of the potential contains Majorana and Heisenberg exchange forces, while the velocity-dependent part is assumed to have a Wigner character. (D.C.W.)

15477 (KAPL-P-3308) SHELL MODEL PREDICTION OF THE EXCITED STATES OF ^{4}He. Szydlik, Paul P. (California Univ., Davis. Knolls Atomic Power Lab., Schenectady, N. Y.); Philpott, R. J. (California Univ., Davis). [1966]. Contracts AT(11-1)-Gen-10; W-31-109-eng-52. 7p. (CONF-670109-2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Annual Meeting of the American Physical Society, New York.

Calculations were performed using the shell model and the random-phase approximation to predict the excited states of ^{4}He. The results were compared with experimental observations. The effects of varying the single-particle energies and the oscillator parameter were investigated, and the differences between energy levels as predicted by the random-phase approximation and the Tamm-Dancoff approximation were determined. (D.C.W.)

15478 RATIO OF THE LARMOR FREQUENCIES OF ^{41}K AND ^{2}H. Lutz, O.; Schwenk, A. (Univ., Tuebingen, Ger.). Phys. Lett., 24A: 122(Jan. 16, 1967).

The ratio of the Larmor frequencies of ^{41}K and ^{2}H and the magnetic moment of ^{41}K was determined. The value is $\nu_{41K}/\nu_{2H} = 0.166,8530 \pm 0.000,000,8$. (auth)

15479 DEUTERON POLARIZATION IN p–d ELASTIC SCATTERING. Extermann, P. (Univ. of Wisconsin, Madison). Nucl. Phys., A95: 615-24(1967). (COO-7-0406).

The vector and tensor polarization of deuterons in p-d elastic scattering was measured by scattering polarized deuterons in the energy range of 4 to 12 MeV from a proton target. The vector polarization is positive at all angles and has a maximum in the backward hemisphere. The largest value observed is $\langle iT_{11} \rangle = 0.050 \pm 0.006$ (E_d = 12 MeV, θ = 120°). The second rank polarization parameters $\langle T_{20} \rangle$ and $\langle T_{22} \rangle$ were measured at 10.1, 11, and 12 MeV; their values range from –0.008 to –0.057. (auth)

15480 POLARIZATION OF PROTONS ELASTICALLY SCATTERED FROM DEUTERONS FROM 4 TO 12 MeV. Clegg, T. B.; Haeberli, W. (Univ. of Wisconsin, Madison). Contract AT(11-1)-Gen-7. Nucl. Phys., A95: 608-14(1967). (COO-7-0405).

The polarized proton beam from the Wisconsin tandem accelerator was scattered from targets of gaseous deuterium and deuterated polyethylene. Left-right asymmetries were measured for the elastically scattered protons and recoil deuterons at 4, 6, 8, 10, and 12 MeV to obtain angular distributions of the proton polarization in the angular range $26° < \theta_{cm} < 160°$. The measured polarization is positive for all angles and energies studied with a peak at about $\theta_{cm} = 120°$. The peak height increases from 0.070 ± 0.005 at 4 MeV to 0.168 ± 0.014 at 12.12 MeV. At some angles and energies measurements were also made to determine the asymmetry of protons from deuteron breakup, the polarization of protons elastically scattered from ^{12}C, and the asymmetry of protons inelastically scattered in the process $^{12}C(p,p')^{12}C^*$ (4.43 MeV). (auth)

15481 NEW DETERMINATION OF THE MAGNETIC MOMENT OF THE PROTON IN TERMS OF THE NUCLEAR MAGNETON. Petley, B. W.; Morris, K. (National Physical Lab., Teddington, Eng.). Nature, 213: 586(Feb. 11, 1967).

The ratio of f_s, the spin precession frequency of the proton, to f_c, the cyclotron frequency in the same magnetic field, is equal to the ratio of the magnetic moment of the proton, μ_p, to the nuclear magneton, μ_n. This ratio is used in combination with other experimentally measured constants to derive best values for atomic constants. Measurements made at 0.47 tesla (4.7 k gauss) are reported. The spin precession frequency was measured with an amplitude bridge and the cyclotron frequency was measured using the megatron method. The cyclotron frequencies of H_2^+, HD^+, and D_2^+ ions were measured, and this enabled shifts caused by electrostatic fields to be eliminated. Results for μ_p/μ_n were 2.79274 ± 0.00005 without, and 2.79282 ± 0.00005 (19 ppm) with correction for the diamagnetism of the water sample. These lie within 1.1 stan-

dard deviations of the previous best value. It is hoped to increase the precision of the method by a factor of ten by working at higher magnetic fields. (auth)

15482 CONTINUOUS ENERGY SPECTRA OF PROTONS AND ALPHA PARTICLES EMITTED BY THE DEUTERON AND ALPHA PARTICLE REACTION. Fukunaga, Kiyoji; Nakamura, Hitoshi; Tanabe, Tetsumi; Hosono, Kazuhiko; Matsuki, Seishi (Kyoto Univ.). J. Phys. Soc. Jap., 22: 28-34(Jan. 1967).

Continuous energy spectra of protons and alpha particles were studied in the deuteron-alpha particle scattering at the incident deuteron energy of 14.2 MeV. In the energy spectra of protons, evidence for a final-state resonance in the neutron and alpha-particle system was obtained, and the energy spectrum is compared with the theory of final-state interaction. There is a good agreement between the experiment and the theory. The angular dependence of the cross sections at peaks shows a stripping-like feature. The energy spectrum of the alpha particles at the higher energy is mainly affected by the effect of the final-state interaction of the triplet S state in the neutron and proton system. The angular dependence of these alpha particles shows a forward peak in the laboratory system, and it may be explained by an exchange process. (auth)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstract 15634.

15483 (CEA-R-3006) CONTRIBUTION A L'ETUDE DES DIFFUSIONS ELASTIQUE ET INELASTIQUES DES PROTONS SUR LE CARBONE 12. (Contribution to the Study of Proton Elastic and Inelastic Scattering on ^{12}C). Sadeghi, Ali (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1966. 72p. (In French). Dep. mn.

Thesis. Submitted to Univ., Paris.

The results of absolute measurements of cross sections for the scattering of protons by ^{12}C to the two first excited levels are given. The measurements were made from 4.6 to 11.4 MeV at 17 angles for (p,p) and at 15 angles for (p,p) (1st excited level) as well as 8 angles for (p,p') (2nd excited level). A gaseous target with differential pumping was used. The elastic scattering was analyzed using the R-matrix theory with the optical model. Then a new analysis of both (p,p) and (p,p') was achieved using the coupled-wave formalism. The information on the levels of the compound nucleus was completed and was confirmed. (auth)

15484 (CEA-R-3009) ETUDE DE QUELQUES SPECTRES CONTINUS PRODUITS PAR REACTIONS NUCLEAIRES AVEC DES NOYAUX LEGERS. (Study of Some Continuous Spectra Produced by Nuclear Reactions With Light Nuclei). Marquez, Luis (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1966. 66p. (In French). Dep. mn.

Thesis. Submitted to Univ., Paris.

The continuous spectra coming from several nuclear reactions with light nuclei were measured. The spectra can be explained by a two-step reaction mechanism; however, the reactions produced by ^{6}Li are different. A mechanism was proposed to explain their spectra based on the following assumptions: ^{6}Li makes a nuclear molecule with the target which subsequently breaks up in such a way that an α particule comes out with the kinetic energy that it has in the molecule. The calculated spectra and those measured are in good agreement. (auth)

15485 (CONF-660221-, pp 56-9) ANGULAR DISTRIBUTION STUDY OF $^{14}N(n,\alpha)^{11}B$ REACTION AT 14 MeV. Chatterjee, M. L. (Saha Inst. of Nuclear Physics, Calcutta (India)).

The angular variation of $\sigma(\theta)$ for the $^{14}N(n,\alpha)^{11}B$ reaction was studied using 14.5-MeV neutrons and Ilford K2 emulsion targets. The distribution of alpha particles from (n,α) reactions with the light emulsion nuclei was obtained as a function of the Q-values. Theoretical fits were made to the angular distributions using a plane-wave Born approximation with zero-range interaction; the results indicate that the heavy-particle stripping mechanism is of importance for this reaction. (D.C.W.)

15486 (CONF-660221-, pp 93-7) STUDY OF $^{13}C(\alpha,n)^{16}O$ AND $^{51}V(p,n)^{51}Cr$ REACTIONS. Sekharan, K. K.; Divatia, A. S.; Mehta, M. K.; Kerekatte, S. S. (Atomic Energy Establishment, Trombay (India)).

The integrated cross section of the reaction $^{13}C(\alpha,n)^{16}O$ was measured over the alpha energy range from 1.95 to 5.5 MeV. 20 resonances indicating levels in the compound nucleus ^{17}O were observed; partial widths were calculated for a number of levels. Two previously unreported resonances at alpha energies of 5.30 and 5.42 MeV, corresponding to levels in ^{17}O at 10.39 and 10.49 MeV, were observed. The total cross section for the inverse reaction $^{16}O(n,\alpha)^{13}C$ was obtained for the neutron energy range from 3.95 to 6.5 MeV using the reciprocity theorem. The integrated cross section of the $^{51}V(p,n)^{51}Cr$ reaction was also obtained for the energy range from 1.9 to 5.5 MeV; the results show that the cross section at low energies is influenced by the Coulomb barrier. (D.C.W.)

15487 (CONF-660221-, pp 128-31) UNDERSTANDING OF SOME PROBLEMS IN NUCLEAR PHYSICS FROM A STUDY OF HYPERNUCLEI. Chaudhari, K. N.; Ganguli, S. N.; Rao, N. K.; Swami, M. S. (Tata Inst. of Fundmental Research, Bombay (India)).

The use of hyperfragments in research in nuclear physics is briefly discussed with emphasis on bound Λ^0-nucleus systems. Some observations on the production of these hyperfragments in nuclear emulsion by high-energy mesons (π) and protons are summarized, and the decay characteristics of some light hypernuclei are discussed. The investigation of nuclear energy levels using hyperfragments is also briefly considered. (D.C.W.)

15488 (CONF-660221-, pp 161-5) STUDY OF ^{18}O NUCLEAR SPECTRA WITH SOFT CORE POTENTIAL. Kumar, N.; Agarwal, G. C.; Bhanot, V. B. (Punjab Univ., Chandigarh (India)).

The energy-level spectrum of ^{18}O was calculated using a soft-core potential; the results are in fairly good agreement with experimental data. The theoretical predictions were also compared with calculations in which Brueckner-Gammel-Thaler, hard-core, and velocity-dependent potentials were used. (D.C.W.)

15489 (COO-1573-7) NUCLEAR PHYSICS LABORATORY PROGRESS REPORT, NOVEMBER 1, 1965-OCTOBER 31, 1966. (Case Inst. of Tech., Cleveland, Ohio. Dept. of Physics). Contract AT(11-1)-1573. 50p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Measurements were made of the polarization of neutrons from the $^{12}C(d,n)^{13}N$ reaction at a deuteron energy of 2.8 MeV. In this work, neutrons are produced in bursts at the target, travel flight paths between 2 and 3 meters, and are subsequently scattered either right or left by ^{4}He which serves as an analyzer. The experimental arrangement of collimator and detector assembly for these neutron polarization experiments is described. Measurements were made of the scattering cross section and left-right asymmetry for 2.2-MeV partially polarized neutrons scattered elastically and inelastically from ^{63}Cu, ^{54}Fe, ^{56}Fe, and ^{60}Ni. Experiments were made on the measurement of the g-factors of the first excited states in ^{162}Dy, ^{164}Dy, ^{166}Er, ^{168}Er, ^{170}Er, and ^{150}Nd. (S.F.L.)

15490 CAPTURE OF NEGATIVE K-MESONS IN DIAMOND-LOADED EMULSIONS. Davis, D. Fournet (Seattle Pacific Coll.); Chinn, L.; Lord, J. J.; Piserchio, R. J. Nuovo Cimento (10), 47A: 573-80(Feb. 1, 1967).

Nuclear emulsions loaded with small diamond crystals were exposed to a stopping beam of K^- mesons. 6125 K^- captures in normal emulsion and 19 K^- captures in carbon were found. Comparisons were made between the K^- absorptions in carbon and normal G-5 emulsion. The average number of prongs was found to be 3.05 in carbon compared to 2.54 in normal G-5 emulsion. In two capture events in carbon, hyperfragments were produced and in one event a Σ^- hyperon was emitted. An analysis of the nature of each hyperfragment was possible due to the known nature of the target nucleus. (auth)

15491 MODIFICATION OF THE EFFECTIVE PARTICLE-HOLE INTERACTION BY CORE POLARIZATION. de Takacsy, N. (California Inst. of Tech., Pasadena). Nucl. Phys., A95: 505-12(1967).

The second-order core-polarization corrections to the effective particle-hole force were calculated using a central potential with Rosenfeld exchange mixture. These corrections do not seem to seriously alter the spectrum of the particle-hole states of ^{16}O. (auth)

15492 LINE SHAPES OF LOW LEVELS IN ^{8}Be VIA THE $^{9}Be(p,d)^{8}Be$ REACTION. Hay, H. J.; Scarr, E. F.; Sullivan, D. J.; Treacy, P. B. (Australian National Univ., Canberra). Austral. J. Phys., 20: 59-66(Feb. 1967).

Reaction mechanisms and line shapes of energy levels in ^{8}Be were studied in the bombardment of ^{9}Be by protons of energies up to 5.2 MeV. The (p,d) process was found to follow a pickup mechanism; with this information, the detailed line shape of the ^{8}Be ground state was inferred. An R-matrix description using a conventional channel radius of 3.5 fm was found not to be in agreement with the results. (auth)

15493 DEUTERON POLARIZATION IN THE $^{9}Be(p,d)^{8}Be$ REACTION. Robinson, D. C. (Univ. of Auckland, New Zealand). Nucl. Phys., A95: 663-72(1967).

The polarization of deuterons emitted at 30° (lab) from the reaction ^{9}Be(p,d)^{8}Be excited at the 330-keV resonance was measured. The result, $P_{33} = 0.83 \pm 0.13$, indicates that the reaction proceeds predominately by compound-nucleus formation through a $J^{\pi} = 1^{-}$ state in ^{10}B (excitation energy 6.89 MeV). The difference between the above measured value of P_{33} and a predicted value may be regarded as support for recent doubt cast on the analyzing power of the ^{3}He(d,p)^{4}He reaction when used for deuteron tensor polarization measurements. (auth)

15494 (^{3}He,d) AND (^{3}He,t) REACTIONS ON ^{9}Be AND ^{11}B. Crosby, M. A.; Legg, J. C. (Rice Univ., Houston, Tex.). Contract AT(40-1)-1316. Nucl. Phys., A95: 639-52(1967). (ORO-1316-15).

The reactions ^{9}Be(^{3}He,d)^{10}B, ^{9}Be(^{3}He,t)^{9}B, ^{11}B(^{3}He,d)^{12}C, and ^{11}B(^{3}He,t)^{11}C were studied. Deuterons were observed leaving ^{10}B at excitations of 0, 0.72, 1.74, 2.15, 3.59, 4.77, 5.16, 5.92, 6.16, and 6.57 MeV. (The 5.16 group probably consists of the unresolved 5.16- and 5.18-MeV states.) Tritons were observed leaving ^{9}B at excitations of 0 and 2.34 MeV. In addition, a typical three-body breakup continuum is seen in the triton spectra. Deuterons leaving ^{12}C at excitations of 0, 4.43, 7.66, 9.64, and 12.71 MeV were observed. Tritons were observed leaving ^{11}C at excitations of 0 and 2.00 MeV. Excitation functions taken in the region of 10 MeV show no strong resonance structure. (auth)

15495 REACTIONS (p,2p) AT 156 MeV. II. ^{6}Li, ^{7}Li, AND ^{9}Be. Roynette, J. C.; Arditi, M.; Jacmart, J. C.; Mazloum, F.; Riou, M.; Ruhla, C. (Institut de Physique Nucleaire, Orsay, France). Nucl. Phys., A95: 545-60(1967). (In French).

Quasi-free proton-proton scattering on ^{6}Li, ^{7}Li, and ^{9}Be was studied at 156 MeV with an overall energy resolution of 2.1 MeV for ^{6}Li and 1.7 MeV for ^{7}Li and ^{9}Be. Two magnetic spectrometers, multichannel scintillation detectors or spark chambers, and an on-line computer were used. Summed energy spectra and angular correlations of the components of these spectra are given. The results suggest 1p + 2s configuration mixing for external protons in ^{6}Li and ^{7}Li. The $(1s)^{-1}$ splitting is observed for both nuclei. (auth)

15496 COMPARISON OF THE YALE, REID, AND HAMADA-JOHNSTON POTENTIALS IN SHELL-MODEL CALCULATIONS. Lynch, R. P.; Kuo, T. T. S. (Princeton Univ., N. J.). Nucl. Phys., A95: 561-70(1967).

The Yale, Reid, and Hamada-Johnson potentials are found to give quite similar results in the shell-model calculations of the nuclei ^{17}O, ^{18}O, and ^{18}F. (auth)

15497 SEQUENTIAL DECAY IN THE REACTION $^{10}B + d \rightarrow \alpha + \alpha + \alpha$. Assimakopoulos, P. A.; Gangas, N. H. (Nuclear Research Centre, Athens). Z. Naturforsch., 21a: 1735-6 (Oct. 1966).

The reaction $^{10}B + d \rightarrow 3\alpha$ was studied at 0.40 MeV in a kinematically complete experiment. It is concluded that the reaction mechanism is predominantly sequential involving the ground state and the first excited state of ^{8}Be. (auth)

15498 STRUCTURE-DEPENDENT ASYMMETRY IN SEQUENTIAL BREAKUP FROM THE REACTION ^{6}Li(^{3}He,pα)^{4}He. Reimann, M. A.; Martin, P. W.; Vogt, E. W. (Univ. of British Columbia, Vancouver). Phys. Rev. Lett., 18: 246-9(Feb. 13, 1967).

A cylindrical asymmetry about the direction of motion of ^{5}Li in the breakup of the ground state of this nucleus as an intermediate state in the reaction ^{6}Li(^{3}He,pα)^{4}He was studied. It was shown that this asymmetry in the secondary decay of the sequential breakup process can be explained in terms of the structure of the intermediate state during the primary reaction in which a neutron is transferred from ^{6}Li to ^{3}He. (D.C.W.)

15499 OPERATION OF THE ISOBARIC SPIN SELECTION RULE IN THE ^{10}B(^{4}He,^{4}He')^{10}B* REACTION. Coop, K. L.; Poate, J. M.; Titterton, E. W. (Australian National Univ., Canberra). Nature, 213: 587(Feb. 11, 1967).

The second excited state of ^{10}B at 1.74 MeV is thought to be the T = 1 analog of the ground states of the neighboring isobars ^{10}Be and ^{10}C. If isobaric spin is conserved in the reaction it should not be possible to populate a pure T = 1 excited state in ^{10}B, since both ^{4}He and the ^{10}B ground state have isobaric spin T = 0. Earlier experimenters have searched for the 1.74-MeV state through the ^{10}B(d,d')^{10}B* reaction but obtained no evidence for it. For the reaction allowed by isobaric spin ^{10}B(p,p')^{10}B*, scattering to both the T = 1 and T = 0 states was observed. In earlier experiments peaks were observed corresponding to the lowest three excited states with the ^{10}B(^{3}He,^{3}He')^{10}B* reaction. The isobaric spin selection rule was tested for the reaction ^{10}B(^{4}He,^{4}He')^{10}B*. The relative cross sections for ^{4}He scattering to the ground state and lowest three excited states of ^{10}B at a laboratory angle of 40° were measured. Experimental details are outlined. The work provided no evidence for the existence of a group of inelastically scattered ^{4}He particles corresponding to excitation of the 1.74-MeV T = 1 state, which indicates that the isobaric selection rule is obeyed. (auth)

15500 THE ELASTIC SCATTERING OF ^{3}He BY ^{10}B AT 9.8 MeV. Patterson, J. R.; Poate, J. M.; Robson, B. A.; Titterton, E. W. (Australian National Univ., Canberra). Proc. Phys. Soc. (London), 90: 577-9(Feb. 1967).

The angular distribution for the ^{10}B(^{3}He,^{3}He)^{10}B reaction was measured at 9.8 MeV, and optical-model parameters were determined. (auth)

15501 REACTIONS OF 1- TO 5-MeV DEUTERONS ON CARBON. Hodgson, P. E. (Oxford Univ.); Wilmore, D. Proc. Phys. Soc. (London), 90: 361-80(Feb. 1967).

The differential cross sections of most of the energetically allowed reactions of deuterons on ^{12}C are calculated using the optical model and the Hauser–Feshbach [Phys. Rev., 87: 366-73 (1952)] and distorted-wave theories. Comparison is made with the experimental data. (auth)

15502 THE STRUCTURE OF THE GIANT DIPOLE RESONANCE. IV. THE ANGULAR DISTRIBUTIONS OF ^{15}N(p,γ_0)^{16}O. Earle, E. D.; Tanner, N. W. (Oxford Univ.). Nucl. Phys., A95: 241-70(1967).

The angular distributions of the gamma rays from the ^{15}N(p,γ_0)^{16}O reaction were studied at 60 different energies between 13- and 25-MeV excitation in ^{16}O. In general, these angular distributions have a maximum value near 80° and a minimum at 0°. The experimental errors were in the region 3 to 5%. The Legendre polynomial coefficients A_0 to A_3 were extracted from the data and with this information spins and parities were assigned to different parts of the cross section. Most of the cross section is due to d-wave protons forming 1^{-} states in ^{16}O. Even the 13.08-MeV state, heretofore thought to be nearly pure $p^{-1}2s$, has a large $p^{-1}d$ component. Two 2^{+} states were observed near 15.25 and 19.1 MeV. Above 20 MeV, the angular distributions were very similar and indicated the presence of a very broad 2^{+} state. In addition, the data may imply the presence of a very broad 1^{-} state, as distinct from the several sharp 1^{-} states apparently seen in the region of giant dipole excitation. A comparison with the coupled-channel shell-model calculations of Buck and Hill is very encouraging and implies a major success for the shell model. (auth)

15503 CALCULATION OF PHOTONUCLEAR RESONANCE CROSS SECTIONS BY COUPLED CHANNEL REACTION THEORY. Buck, B.; Hill, A. D. (Oxford Univ.). Nucl. Phys., A95: 271-319(1967).

The methods of nuclear reaction theory are applied to calculate the properties of giant dipole resonance states in ^{16}O. The resonances are treated as scattering states in which a nucleon interacts with the corresponding mass-15 system and induces various nuclear reactions in the channels with total quantum numbers $J^{\pi} = 1^{-}$. The wave functions produced by this model are used to compute several photonuclear cross sections for a range of energies. (auth)

15504 ON THE INTERACTIONS OF 17.2 GeV π^{-} WITH LIGHT AND HEAVY EMULSION NUCLEI. Kohli, J. M.; Mittra, I. S.; Singh, M. B. (Panjab Univ., Chandigarth, India). J. Phys. Soc. Jap., 22: 1-6(Jan. 1967).

Some 257.7 m of track length was followed, and 631 interactions were picked up. These events were separated into π^{-} AgBr and π^{-} CNO groups of nuclei on the basis of Lohrmann et al selection criterion and also on the assumption that the overall numbers of events belonging to AgBr and CNO nuclei are governed by the geometrical cross sections. The results regarding the mean multiplicity, angular, and momentum distributions are similar in the cases of the selection criteria mentioned and lend some support to the inter-nuclear cascade model. (auth)

15505 (p,d) REACTIONS IN $1p_{\frac{1}{2}}$ SHELL NUCLEI AT 40 MeV. Short, Thomas Hale. Minneapolis, Univ. of Minnesota, 1965. 83p. Thesis.

The (p,d) reaction on ^{6}Li, ^{7}Li, ^{9}Be, ^{10}B, ^{11}B, and ^{12}C was studied down to about 18-MeV deuteron energy for a proton energy of 39.8 MeV using a magnetic spectrometer. A comparison of the levels excited in (p,d) with those of higher energy (p,2p) experiments shows many isospin analog states. Absolute differential cross sections were measured from 7.5 to 30° for the strongly excited states except that only the ground state was done for carbon. Butler curves are calculated and best fits are shown; L = 1 momentum transfer gives significantly better fits than other L values except for an L = 0 level in ^{5}Li. In general the fits of the curves to the data are poor with small reaction radius for small Q-values. For large Q-value levels the agreement is good. Reduced widths are about an order of magnitude larger than those found at lower

energy for the same reactions. Agreement of relative spectroscopic factors with theoretical predictions is mixed. (Dissertation Abstr.)

15506 COMPLEX PHASE SHIFT ANALYSIS OF ELASTICALLY-SCATTERED PROTONS FROM CARBON. Swint, Jerry Bill. Houston, Tex., Rice Univ., 1966. 88p.

Thesis.

The scattering of protons from carbon in the range of incident energies 4.7 to 12.8 MeV was investigated using a tandem Van de Graaff accelerator and a differentially pumped gas scattering chamber with solid-state detectors. Absolute differential cross sections for elastic scattering and for the inelastic scattering reactions $^{12}C(p,p')^{12}C^*$ (Q = −4.43 MeV) and $^{12}C(p,p')^{12}C^*$ (Q = −7.66 MeV) were measured at laboratory angles of 25.54, 85.22, 105.23, 121.16, 137.52, and 159.45° as a function of energy in steps of 2.5 to 20 keV. Cross sections as a function of angle for elastic scattering, and for the reactions which occur, were measured at incident proton energies E_p = 2.39, 2.97, 3.97, 4.99, 5.66, 6.18, 6.65, 6.77, 8.07, 8.20, 8.39, 8.96, 9.10, 9.13, 9.15, 9.16, 9.39, 9.81, and 11.60 MeV. Of particular interest is the splitting of the known 9.14-MeV anomaly, indicating a previously unknown level. Complex phase shifts were obtained to represent the elastic-scattering cross sections, the total reaction cross sections, and certain polarization data. The complex phase shifts at the above discrete energies were used to estimate a continuous energy-dependence for the phase shifts in the range $5.0 \leq E_p \leq 9.5$ MeV, omitting the rapid energy variation due to narrow levels. The estimates were varied slightly to obtain a good fit (except over narrow levels) to the cross sections as a continuous function of energy. Then the narrow levels were included by means of a single-level form in a calculation of the differential elastic-scattering cross section, the total reaction cross section, and the polarization at θ_{lab} = 50°, all as a continuous function of energy. The calculation adequately reproduced the experimental data through most of the energy range. The results differed significantly from the experimental results above E_p = 8.5 MeV since only one state of the 9.14-MeV doublet was included in the calculations. A contour map of the spin polarization versus energy and angle was prepared on the basis of the above calculation. The complex phase shift analysis of the 8.20- and 9.14-MeV anomalies confirmed the $\frac{7}{2}^-$ assignment at 8.20 MeV and $\frac{5}{2}^-$ for the stronger state at 9.14 MeV. The weaker state of the doublet, which is lower in energy, has $J^\pi = \frac{5}{2}^-$, confirming an assignment by Terrell and Bernstein. (Dissertation Abstr.)

15507 PHOTONEUTRON REACTIONS IN ^{16}O. Moyer, William R. Troy, N. Y., Rensselaer Polytechnic Inst., 1966. 105p.

Thesis.

Photoneutron energy spectra were measured for the giant dipole resonance energy region of ^{16}O at selected bremsstrahlung endpoint energies from 22.7 to 70 MeV at angles of 90, 67.5, and 45° between the γ beam and emitted neutrons. The neutron energy is measured by the time-of-flight technique over a 100-m flight path with a resolution of 0.16 nsec/m. The detailed shape of the neutron spectrum was determined in the region of the 17.27-MeV peak and between 18 to 26 MeV (ground state excitation energy). Excitation-function analysis was performed to obtain the relative differential cross section for $^{16}O(\gamma,n_0)^{15}O$ over the γ energy range from 18 to 26 MeV and to set upper limits on the relative cross section for transitions which leave the residual ^{15}O nucleus in the 5.2-MeV state(s) and 6.16-MeV state. (Dissertation Abstr.)

Nuclear Properties and Reactions, 20 ≤ A ≤ 89

Refer also to abstracts 15461, 15478, 15486, 15489, 15603, 15605, 15634, and 15636–15638.

15508 (CONF-660221–, pp 60-4) MEASUREMENTS ON 14 MeV NEUTRON INDUCED REACTION CROSS-SECTIONS USING ENRICHED ISOTOPES OF CALCIUM. Tiwari, P. N.; Kondaiah, E. (Tata Inst. of Fundamental Research, Bombay (India)).

A shielded gamma counting system using an NaI(Tl) well-type crystal was built for the measurement of small reaction cross sections. The cross sections for the reactions $^{27}N(n,p)^{27}Mg$, $^{40}Ca(n,t)^{38g}K$, $^{42}Ca(n,p)^{42}K$, $^{43}Ca(n,p)^{43}K$, $^{44}Ca(n,p)^{44}K$, $^{44}Ca(n,\alpha)^{41}Ar$, $^{44}Ca(n,\alpha)^{43}K$, $^{46}Ca(n,2n)^{45}Ca$, and $^{45}Sc(n,2n)^{44}Sc$ were measured using photopeak efficiencies. (D.C.W.)

15509 (CONF-660221–, pp 66-8) MEASUREMENT OF THE ABSOLUTE (n,2n) CROSS SECTION OF LOW Z NUCLEI FOR 14.8 MeV NEUTRONS. Chatterjee, Arun; Mitra, B.; Ghose, A. M. (Bose Inst., Calcutta (India)).

Absolute cross sections for (n,2n) reactions on ^{63}Cu, ^{19}F, ^{69}Ga, ^{107}Ag, and ^{64}Zn at 14 MeV were obtained by measuring the absolute value of the neutron flux used for irradiation and the absolute value of the resulting positron activity. (D.C.W.)

15510 (CONF-660221–, pp 75-9) RESONANCE SCATTERING OF THERMAL NEUTRON CAPTURE GAMMA RAYS. Hans, H. S. (Kurukshetra Univ. (India)).

The observation and use of the resonance scattering of capture gamma rays in nuclear spectroscopy is briefly discussed; and the results of some observations of capture-gamma resonance scattering by ^{11}B, ^{78}Se, and ^{88}Sr are presented including level spins, parities, and widths as well as cross sections. (D.C.W.)

15511 (CONF-660221–, pp 84-8) MECHANISM OF THE $^{51}V(p,n)^{51}Cr$ REACTION. Iyengar, K. V. K.; Gupta, S. K.; Lal, B. (Tata Inst. of Fundamental Research, Bombay (India)).

The n−γ angular correlations in the reaction $^{51}V(p,n\gamma)^{51}Cr$ were measured, together with gamma excitation functions and neutron spectra. The data were analyzed using Satchler's theory. The gamma excitation functions indicate that the statistical assumption is valid for the compound nucleus ^{52}Cr in the region of excitation considered. The n−γ correlations with respect to θ_γ = 90° are symmetric at certain neutron detection angles and, in a few cases, are also isotropic. (D.C.W.)

15512 (CONF-660221–, pp 89-92) PROTON INDUCED REACTIONS ON ^{51}V. Sarma, N. (Atomic Energy Establishment, Trombay (India)); Deshpande, V. K.; Mehta, G. K.; Sood, D. K. (Indian Inst. of Tech., Kanpur).

Excitation functions for proton elastic scattering by ^{51}V at 2.5 to 5.5 MeV were measured at 90 and 210°. Prominent peaks in the excitation curves around 3.1 MeV and a visually noticeable correlation between the two curves at least up to 4.15 MeV were noted. (D.C.W.)

15513 (CONF-660221–, pp 98-103) STATES IN $^{56}Fe_{30}$ EXCITED BY THE (p,p'γ) REACTION. Trehan, P. N.; Singhal, N. C.; Mangal, P. C. (Punjab Univ., Chandigarh (India)).

Gamma spectra and yields from proton inelastic scattering by ^{56}Fe at 4.8 to 5.95 MeV were measured, and production cross sections were obtained from the yields. Spin and parity assignments were made for ^{56}Fe levels, and a level scheme for ^{56}Fe was proposed. (D.C.W.)

15514 (CONF-660221–, pp 110-13) THE TWO-NUCLEON STRIPPING REACTION, $^{40}Ca(^3He,p)^{42}Sc$. Jain, B. K.; Sarma, N. (Atomic Energy Establishment, Trombay (India)).

The differential cross section for the reaction $^{40}Ca(He\text{-}3,p)^{42}Sc$ was calculated using a modified zero-range approximation in the distorted-wave formalism. The effect of varying the optical-model parameters for ^3He and protons on ^{40}Ca and ^{42}Sc was investigated. (D.C.W.)

15515 (CONF-660221, pp 114-19) SPINS OF THE FIRST TWO EXCITED STATES IN ^{27}Mg BY PROTON GAMMA RAY ANGULAR CORRELATION MEASUREMENTS IN THE REACTION $^{26}Mg(d,p\gamma)^{27}Mg$. Eswaran, M. A. (Atomic Energy Establishment, Trombay (India)).

Gamma spectra and p−γ angular correlations from the reaction $^{26}Mg(d,p\gamma)^{27}Mg$ at 1.8 MeV were measured. Least-squares fits to the p−γ angular distributions were made using even-order Legendre polynomial functions. On the basis of the data analysis, spin assignments were made for the first two excited states of ^{27}Mg. (D.C.W.)

15516 (CONF-660221–, pp 120-2) ELASTIC SCATTERING OF ALPHA PARTICLES BY ^{24}Mg. Kerekatte, S. S.; Mehta, M. K.; Divatia, A. S.; Sekharan, K. K. (Atomic Energy Establishment, Trombay (India)).

Excitation functions for alpha elastic scattering by ^{24}Mg at 3.44 to 5.50 MeV were measured at laboratory angles of 80.5 and 164°. Ten resonances were observed in the excitation function at 164°, corresponding to levels in the compound nucleus ^{28}Si. A procedure for assigning spins to the levels of ^{28}Si was established. (D.C.W.)

15517 (CONF-660221–, pp 140-4) SURFACE DELTA INTERACTION AND ^{40}K. Shah, M. S.; Pandya, S. P. (Physical Research Lab., Ahmedabad (India)).

The energy-level scheme of ^{40}K was analyzed using the surface delta interaction and including the effects of mixing in states with $S_{\frac{1}{2}}{}^1f_{\frac{7}{2}}$ configuration. The results were compared with the results of calculations in which a conventional delta interaction was used. (D.C.W.)

15518 (CONF-660221–, pp 181-3) MAGNETIC MOMENT OF THE 280 keV $(5/2^-)$ LEVEL IN ^{75}As. Agarwal, Y. K.; Baba, C. V. K. (Tata Inst. of Fundamental Research, Bombay (India)).

The magnetic moment of the 280-keV level of ^{75}As was measured by observing perturbed γ−γ directional correlations. The lifetime of the level was calculated from experimentally determined parameters. (D.C.W.)

15519 (CONF-660221–, pp 222-3) DECAY OF ^{76}Ga. Sethi, B.; Mukherjee, S. K. (Saha Inst. of Nuclear Physics, Calcutta (India)).

The beta and gamma spectra of ^{76}Ga produced in the irradiation of Ge with 14-MeV neutrons were measured. It was concluded that the 0.560-MeV level of ^{76}Ge was populated by the 5.8-MeV beta group from the decay of ^{76}Ga. A decay scheme is proposed for ^{76}Ga. (D.C.W.)

15520 (CONF-660221–, pp 239-42) INTERNAL CONVERSION OF ^{57}Fe GAMMA RAYS. Suri, S. K. (Delhi Univ. (India)); Varma, J. (Udaipur Univ. (India)).

The branching ratio of the 122-keV transition in ^{57}Fe was measured using a fast-slow coincidence technique, and the internal conversion coefficient of the 14.4-keV gamma rays was measured both by comparing the intensity of the K x rays with that of the 14.4-keV gamma rays and by comparing the intensities of the 14.4- and 122-keV gamma rays. (D.C.W.)

15521 (NASA-TN-D-3548) INVESTIGATION OF THE (d,α) REACTION ON ^{27}Al. Priest, Joseph R.; Vincent, John S. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Feb. 1967. 18p.

The angular distributions of seven alpha-particle groups from the (d,α) reaction on ^{27}Al were measured. The deuteron energy was 20.9 MeV in the laboratory system. The angular distributions are all peaked in the forward direction and have little structure. The integrated differential cross sections for those reactions that leave the ^{25}Mg nucleus in the K = $5/2^+$ rotational states are, in general, more than one order or magnitude larger than those that leave ^{25}Mg in the K = $1/2^+$ rotational states. The angular distributions corresponding to a given rotational band in ^{25}Mg are strikingly similar both in magnitude and shape. Analysis of the energy-level structure in terms of the rotational model indicates that the state in ^{25}Mg at 5.47 ± 0.03 MeV is the $11/2^+$ member of the K = $5/2$ band. (auth)

15522 (NP–16556) OBZOB RABOT, NOYABR' 1964 G–NOYABR' 1965 G. (A Review of Works [on Nuclear Physics] Performed November 1964–November 1965). (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1966. 82p. (In Russian). Dep. mn.

Abstracts are presented of the 33 theoretical and experimental works published by members of the Fiziko-Tekhnicheskii Institut from November 1964 to November 1965. (J.S.R.)

15523 INELASTIC SCATTERING OF α-PARTICLES BY ^{60}Ni. Tamura, Taro (Oak Ridge National Lab., Tenn.). Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 383-91(1966). (ORNL-P-2525).

Data of a ^{60}Ni(α,α')^{60}Ni* reaction were analyzed in terms of the coupled-channel calculations. Good agreement with experimental scattering cross sections was obtained, and from such an agreement spectroscopic informations on ^{60}Ni were derived. These informations turned out to be in good accord with what were derived from a similar analysis of a ^{60}Ni(d,d')^{60}Ni* data. (auth)

15524 MASS-SPECTROMETRIC DETECTION OF COSMIC-RAY-PRODUCED ^{81}Kr IN METEORITES AND THE POSSIBILITY OF Kr–Kr DATING. Marti, Kurt (Univ. of California, San Diego, La Jolla). Contract AT(11-1)-34. Phys. Rev. Lett., 18: 264-6(Feb. 13, 1967).

^{81}Kr, the first detected cosmic-ray–produced radioactive nucleus heavier than the Fe–Ni group, was found to be present in meteorites. The radiation age of the Macibini meteorite is calculated from the measured isotopic composition of krypton. This dating method should be applicable to most stone and stony-iron meteorites. (auth)

15525 RADIOACTIVE TRANSFORMATIONS ACCOMPANIED BY PROTON EMISSIONS. Daroczy, Sandor (Inst. for Nuclear Research, Hungarian Academy of Sciences, Budapest). Magyar Fiz. Foly., 14: 317-40(1966). (In Hungarian).

A review is given of literature on the radioactive transformations of proton-rich nuclei involving proton emission. The review includes a historical account of the subject. (50 references). (S.F.L.)

15526 MASS SPECTROMETRIC DUAL COLLECTOR FOR PRECISE STRONTIUM ISOTOPE ABUNDANCE RATIO MEASUREMENTS. Hayatsu, A.; Farquhar, R. M. (Univ. of Toronto). J. Sci. Instrum., 44: 141-5(Feb. 1967).

A simple dual collector is described, which was developed and used with an AEI MS2 mass spectrometer for precise measurements of isotopic abundance ratios of strontium. The average ratio and standard deviation of normalized ^{87}Sr/^{86}Sr ratios estimated from ten replicate analyses on a standard solution is 0.7126 ± 0.0003. (auth)

15527 REACTIONS (p,2p) AT 156 MeV. I. NUCLEI WITH Z = 20 TO 28. Ruhla, C.; Arditi, M.; Doubre, H.; Jacmart, J. C.; Liu, M.; Ricci, R. A.; Riou, M.; Roynette, J. C. (Institut de Physique Nucleaire, Orsay, France). Nucl. Phys., A95: 526-44 (1967). (In French).

Quasi-free proton-proton scattering at Ca and eight $1f_{7/2}$ shell nuclei was studied at E_p = 156 MeV with an overall energy resolution of 2.1 MeV using two magnetic spectrometers. The $2s_{1/2}$ shell levels were detected in the summed energy spectra; some angular correlations were measured. The $2s_{1/2}$ shell is shallow; the binding energies are 11 to 14 MeV. This implies that for these nuclei a gap of at least 20 MeV exists between the 2s, 1d and 1s, 1p regions. (auth)

15528 ELASTIC SCATTERING OF 2.76 MeV NEUTRONS BY CALCIUM. PRELIMINARY NOTE. Winterhalter, Dragica (Ruder Boskovic Inst., Zagreb. Univ. of Zagreb). Glas. Mat.-Fiz. Astron., Ser. II, 20: 271-6(1965).

Differential cross sections and spectra for the elastic scattering of 2.76-MeV neutrons by Ca (99.9% ^{40}Ca) were measured together with the neutron total cross section of Ca. (D.C.W.)

15529 STUDY OF THE ^{22}Ne(d,d)^{22}Ne, ^{22}Ne(d,p)^{23}Ne, ^{22}Ne(d,t)^{21}Ne, AND ^{22}Ne(p,d)^{21}Ne REACTIONS. Lutz, H. F.; Wesolowski, J. J.; Hansen, L. F.; Eccles, S. F. (Univ. of California, Livermore). Nucl. Phys., A95: 591-607(1967). (UCRL–70193).

The nuclear reactions ^{22}Nd(d,d)^{22}Ne, ^{22}Ne(d,p)^{23}Ne, and ^{22}Ne(d,t)^{22}Ne induced with 12.1-MeV deuterons and ^{22}Ne(p,d)^{21}Ne induced with 18.2-MeV protons were studied by employing a gas target of enriched ^{22}Ne and beams accelerated in the Livermore variable-energy cyclotron. The results were analyzed with the nuclear optical model and DWBA calculations. The neutron-transfer reactions were compared with the predictions of the Nilsson model. The results for the pickup reactions going to the first three levels of ^{21}Ne are in good agreement with the predictions of the Nilsson model. The RPC model (rotational and particle motion with Coriolis band mixing) modified for pairing effects was employed in an effort to obtain at least a qualitative explanation of the transitions leading to ^{23}Ne. There are certain large discrepancies consisting of strong transitions that are predicted theoretically under a wide range of assumptions but not seen experimentally. These results indicate that further detailed calculations are necessary to understand the structure of this nucleus. (auth)

15530 ISOSPIN-FORBIDDEN DECAY OF THE 0^+, T = 2 STATE AT 15.43 MeV IN ^{24}Mg. McGrath, Robert L.; Cosper, S. W.; Cerny, Joseph (Univ. of California, Berkeley). Phys. Rev. Lett., 18: 243-6(Feb. 13, 1967).

The sought, but previously unobserved, isospin-forbidden particle-decay modes of a T = 2 state in a T_z = 0 nucleus were determined by particle-particle coincidence techniques. Proton decays (ΔT = 1 or 2) and strong evidence for α-particle decays (ΔT = 2) from the T = 2 state of ^{24}Mg were observed and show $\Sigma\Gamma_{particle} \gg \Gamma_\gamma$. (auth)

15531 STUDY OF THE γ RADIATION OF ^{77}Ge. Dalmasso, Josette; Maria, Henriette (Faculte des Sciences, Alpes-Maritimes, France). Compt. Rend., Ser. B, 263: 1415-17(Dec. 19, 1966). (In French).

The γ radiation of ^{77}Ge was studied using a semiconductor spectrometer. The energy and relative intensity of 47 γ rays were determined. In the ^{56}Co used as standard, two previously unreported γ rays were observed at 2310.8 and 3369 keV. (tr-auth)

15532 TWO-BODY SPECTRUM IN THE $1f_{7/2}$ SHELL. Schwartz, J. J. (Univ. of Rochester, N. Y.). Phys. Rev. Lett., 18: 174-6 (Jan. 30, 1967).

Measurements are reported which identify six of the $1f_{7/2}$ states in ^{48}Sc and, through a particle-hole transformation to ^{42}Sc, suggest plausible excitation energies of the remaining unknown $(f_{7/2})^2$ and $(f_{7/2})(f_{7/2})^{-1}$ levels of ^{42}Sc and ^{48}Sc. (M.H.R.)

15533 ELASTIC AND INELASTIC SCATTERING OF 14.1-MeV NEUTRONS FROM Ni AND Zr. Clarke, R. L.; Cross, W. G. (Atomic Energy of Canada, Ltd., Chalk River, Ont.). Nucl. Phys., A95: 320-36(1967).

The differential cross sections were measured for the elastic scattering of 14.1-MeV neutrons from Ni and Zr and for inelastic scattering from the excited states in Ni near 1.4 MeV and in Zr near 2.3 MeV. For elastic scattering, satisfactory optical model fits were obtained. No scattering to higher states in Ni was observed. The angular distribution for scattering to the lowest 2^+ states in Ni was fitted by a distorted-wave Born approximation calculation. The magnitude of this scattering yielded 0.22 ± 0.03 for the average value of β_2 for the Ni isotopes, in agreement with values derived from other particle-scattering experiments and from electromagnetic measurements. The observed inelastic scattering from Zr was quantitatively consistent with the excita-

tion of the lowest 2^+ state in ^{90}Zr and 3^- states in all the Zr isotopes. It was found that a correction factor of 1.08 ± 0.02 should be applied to the previously measured cross sections of C, Si, and S. (auth)

15534 ISOMERIC CROSS-SECTION RATIOS IN THE (n,γ) REACTIONS OF ^{76}Ge AND ^{82}Se. Iyer, R. S.; Ramaniah, M. V.; Rao, C. L.; Prakash, Satya (Atomic Energy Establishment, Trombay, India). J. Inorg. Nucl. Chem., 29: 281-5(Feb. 1967).

The cross-section ratios for the formation of the isomeric pairs ^{77}Ge, ^{77m}Ge, ^{83}Se, and ^{83m}Se by (n,γ) reactions on ^{76}Ge and ^{82}Se, respectively, were measured by a radiochemical method involving the estimation of their daughter activities ^{77}As and ^{83}Br. The isomer ratios $\sigma_g/(\sigma_g+\sigma_m)$ were determined to be 0.23 ± 0.02 for ^{77}Ge and 0.07 ± 0.01 for ^{83}Se isomers. (auth)

15535 RADIATIVE CAPTURE OF SLOW NEUTRONS IN THE THERMAL AND RESONANCE REGIONS. Spreckelsen, K. (Technische Hochschule, Darmstadt, Ger.). Z. Phys., 199: 433-9(1967). (In German).

Within the framework of the many-level R-matrix formalism, the theory of Lane and Lynn allows one to calculate the partial cross sections for radiative capture of thermal and resonance neutrons. If the cross section for capture to a given final state of the product nucleus has been measured for a number of neutron energies in the thermal and resonance regions, then the variation of the above cross section with incident neutron energy can be completely determined. This calculation was carried out for the reaction ^{55}Mn (n,γ)^{56}Mn for two distinct final states of ^{56}Mn, where enough data are available to fix the parameters for resonance internal capture. (auth)

15536 TRITIUM YIELDS FROM THE REACTIONS Ni(γ,t) AND Pd(γ,t) WITH 36.2-MeV AND 49.2-MeV BREMSSTRAHLUNG. Kneisel, P.; Goldmann, A.; Buttlar, H. v. (Technische Hochschule, Darmstadt, Ger.). Z. Phys., 199: 440-4(1967). (In German).

The yield of triton production from Ni and Pd with bremsstrahlung of maximum energy 36.2 and 49.2 MeV was measured relative to the yield of the reaction C(γ,n)^{11}C. The tritium was extracted from the irradiated samples by heating them to 500°C in hydrogen. It was then transferred into a low-level gas counter. The ratio of the yields at 49.2 MeV was found to be 4.6 ± 0.4 10^{-3} for Ni and 6.1 ± 1.0 10^{-3} for Pd. Statistical model calculations show good agreement for Ni; for Pd, however, the experimental yield exceeds the theoretical prediction by two orders of magnitude. (auth)

15537 HOLE STATES IN NUCLEI: ^{41}Ca AND ^{47}Ca. Sartoris, G.; Zamick, L. (Rutgers-The State Univ. of New Jersey, New Brunswick). Phys. Rev. Lett., 18: 292-4(Feb. 20, 1967).

The wave functions of low-lying positive-parity states of ^{41}Ca and ^{47}Ca were calculated by assuming a configuration consisting of one hole in the 2s-1d shell and the valence nucleons in the 1f-2p shell. (auth)

15538 ELASTIC AND INELASTIC SCATTERING OF PROTONS ON ^{22}Ne AND THE T = 1/2 AND T = 3/2 ENERGY LEVELS OF ^{23}Na. Katori, Kenji (Nippon Atomic Industry Group Co. Ltd., Kawasaki, Japan); Chiba, Ren; Etoh, Kiichi; Murata, Tohru; Mori, Masushi; Kawai, Nawoyuki; Takayanagi, Seiichi. J. Phys. Soc. Jap., 22: 35-45(Jan. 1967).

Excitation functions for elastic scattering of protons on ^{22}Ne were studied at θ_{cm} = 56.9, 92.6, 125.7, 140.8, and 151.3° in the energy range E_p = 0.94 to 4.2 MeV. The excitation function for protons inelastically scattered to the first excited state of ^{22}Ne was measured at θ_{lab} = 139.1° above E_p = 2.1 MeV, and the γ rays following them were observed below E_p = 2.1 MeV. A total of 75 resonances was observed corresponding to ^{23}Na levels between 9.7 and 12.8 MeV. Several pronounced resonances are analyzed using the single-level approximation of the dispersion formula, and level parameters are assigned. The T = 3/2 isobaric analogue states in ^{23}Na and ^{23}Ne are discussed. (auth)

15539 PROPERTIES OF LEVELS IN ^{35}Cl. Taras, Paul. Toronto, Univ. of Toronto, 1965.

Thesis.

The spins and parities of six excited levels in ^{35}Cl and the multipolarities, branching ratios and mixing ratios of the gamma rays emitted in the de-excitation of these levels were studied. The levels were populated at two resonances in the ^{34}S(p,γ)^{35}Cl reaction. The first resonance, at proton energy 1.213 MeV, populated the 7.544-MeV level in ^{35}Cl which then decayed to the 3.16-MeV level and subsequently to the ground state. The second resonance, at proton energy 1.513 MeV, populated the 7.841-MeV level in ^{35}Cl. This level in turn decayed to the following states: the 4.17-MeV level, the 3.00-MeV level, the 2.645-MeV level, the 1.22-MeV level, and the ground state. The triple angular correlations of all the gamma-gamma cascades, except one, were measured. The 7.841 MeV → 2.645 MeV → ground-state cascade was found to be too weak to produce any meaningful data. The usual triple angular correlation method was discarded in favor of sum coincidence techniques. The spins of the levels and the mixing ratios of the gamma rays involved were deduced from the triple angular correlation measurements. The parities of the levels were inferred on the basis of transition probabilities when the gamma ray transitions were found to consist of mixed multipole radiations. The branching ratios of the gamma transitions emitted from the resonance levels at 7.544 MeV and 7.841 MeV were obtained from the full energy peaks of the sum coincidence spectra. The 7.841-MeV level and the 4.17-MeV level were found to have the same parity. The unified model was applied to the ^{35}Cl decay scheme. The theoretical predictions of the model are consistent with the experimental data available so far; of the low-lying levels in ^{35}Cl, only the 3.00-MeV level is not accounted for. On the evidence presented, of all the nuclear models available, the unified model seems to provide the best description of the properties of the ^{35}Cl nucleus. (Dissertation Abstr.)

15540 PROPERTIES OF NUCLEAR LEVEL DENSITIES FROM INELASTIC PROTON SCATTERING. Johnson, Richard Ray. Minneapolis, Univ. of Minnesota, 1965. 117p.

Thesis.

Inelastic proton and alpha spectra were observed from (p,p′) and (p,α) reactions on ^{59}Ni, ^{60}Ni, ^{63}Cu, ^{65}Cu, ^{64}Zn, and ^{66}Zn at bombarding energies around 10 MeV. ^{63}Cu and ^{64}Zn inelastic proton yield curves for bombarding energies ranging from 9.5 to 10.5 MeV indicate some possible intermediate or doorway state resonance structure. Nuclear temperatures, T, were determined for the residual nuclei in these reactions from log $(d^2\sigma/d\epsilon d\Omega/\epsilon\sigma_c)$ plots, and were found to agree with temperatures from N(U) or Ericson plots (direct level counts) when the temperatures were obtained from the same excitation region. Using the level density formula, $\rho(U) = \exp(U-\Delta/T)$, where U is the residual nuclear excitation, the energy gap, Δ, was calculated from (p,p′) to (p,α) yield ratios and found to agree with Δ's obtained from N(U) plots or from Cameron's pairing energy tables. Departures or fluctuations in the number of levels in an energy interval δU were determined from yield fluctuations and compared with fluctuations predicted from gaussian probability distributions with variances calculated from several theoretical level spacing distributions. A Wigner spacing distribution applicable to nuclear spectra implies a level number variance of $0.27\bar{N}$ where $\bar{N}+1$ is the average number of levels in an energy interval δU. Analysis of the experimental fluctuations gave a variance of $K\bar{N}$ where $0.1 \le K \le 0.3$. The method could, in principle, be inverted to determine the energy gap parameter, Δ, which in turn determines the absolute value of the level density. (Dissertation Abstr.)

15541 γ-γ DIRECTIONAL CORRELATIONS IN THE SEMI-MAGIC ^{88}Sr AND ^{116}Sn ISOTOPES. Grenacs, L.; Hess, R.; Gassmann, F. (Eidgenossische Technische Hochschule, Zurich). 6p. (CONF-650979-1). DTIE.

From Swiss Physical Society, Geneva.

The energy levels of ^{88}Sr and ^{116}Sn were investigated by γ-γ angular correlation measurements on the decay of 18-min ^{88}Rb and 54-min ^{116}In, respectively, using two NaI (Tl) detectors and a fast-slow coincidence system. Spin-parity assignments were made, and mixing parameters were determined for one transition in each of the nuclei ^{88}Sr and ^{116}Sn. (D.C.W.)

Nuclear Properties and Reactions, A ≥ 90

Refer also to abstracts 14930, 14942, 15461, 15489, 15504, 15509, 15525, 15536, 15541, 15612, 15637, and 15638.

15542 (BMwF-FBK-66-38) EINE VIER-DETEKTOR-APPARATUR ZUR DIFFERENTIELLEN MESSUNG VON WINKELKORRELATIONEN UND BESTIMMUNG DES KERNQUADRUPOLMOMENTS DES ^{160}Dy. (A Four-Detector-Apparatus for Differential Measurements of Angular Correlations and Determination of the Quadrupole Moment of ^{160}Dy). Krien, K. (Bonn Univ. (West Germany). Institut fuer Strahlen und Kernphysik). Nov. 1966. 54p. (In German). Dep. mn.

A four-detector apparatus for differential measurements of angular correlations was built. From the ratio of the attenuation parameters of the angular correlations obtained for the cascades 1187 - 87 keV and 879 - 87 keV, the quadrupole moment of the 87-keV, 2^+ rotational level of ^{160}Dy was determined. The results $(1 - R)Q_0 = (17.9 \pm 2.0) \times 10^{-24}$ cm^2, disagrees with measurements of the quadrupole moment by use of Coulomb-excitation techniques. An interpretation of this discrepancy has not yet been found. (auth)

15543 (BMwF-FBK-66-39) AUSWERTEPROBLEME BEI EINER VIER-DETEKTOR-APPARATUR ZUR DIFFERENTIELLEN MESSUNG VON WINKELKORRELATIONEN UND MESSUNGEN AM ^{172}Yb. (Problems of Evaluation of Differential Angular Correlation Measurements with a Four-Detector-Apparatus and Investigations with ^{172}Yb). Wagner, H. F. (Bonn Univ. (West Germany). Institut fuer Strahlen und Kernphysik). Nov. 1966. 56p. (In German). Dep. mn.

The formulas for the calculation of differential angular correlation measurements are derived and discussed. An application of these formulas to the problems of a four-detector-apparatus is carried out by means of a numerical computer program. The fully transistorized automatic control of this apparatus is described in detail. The measurement of the 203- 1095 keV-cascade in Yb 172, carried out with the four-detector-apparatus, is discussed. The results of the measurement are given. (auth)

15544 (BNL-11026) MOESSBAUER EFFECT IN ^{99}Ru. Kistner, O. C. (Brookhaven National Lab., Upton, N. Y.). Jan. 27, 1967. Contract AT(30-2)-Gen-16. 28p. (CONF-670110-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 3rd Annual Moessbauer Symposium, New York.

The methodology of studying Moessbauer effect in ^{99}Ru is discussed and illustrated with various magnetic hyperfine spectra. Special attention is given to the uses of ^{99}Ru as a sensitive probe for measuring internal magnetic fields and for testing time reversal invariance. A new type of versatile Moessbauer spectrometer is described. (P.C.H.)

15545 (CONF-660221-) PROCEEDINGS OF THE NUCLEAR PHYSICS AND SOLID STATE PHYSICS SYMPOSIUM, HELD IN BOMBAY, FEBRUARY 21-25, 1966. NUCLEAR PHYSICS. (Department of Atomic Energy, Bombay (India)). 397p. Dep. mn.

Separate abstracts were prepared for 74 of the 77 papers included. Papers dealing with the efficiency of well-type NaI(Tl) crystals for cylindrical γ sources, (n,2n) cross sections and isomer ratios for ^{115}In and ^{92}Mo, the energy levels of ^{146}Eu and ^{140}La, the deformation parameters of odd-A nuclei, and a digital position indicator for neutron diffractometers are included only in abstract form. Three other papers were previously abstracted for NSA (20: 42324, 46669; and 21: 8611). (D.C.W.)

For abstracts of individual papers see: 14387, 14416, 14429, 14471, 14491–14495, 14943–14945, 15103, 15104, 15252, 15439, 15440, 15461–15465, 15475, 15476, 15485–15488, 15508–15520, 15546–15566, 15609–15615, 15643–15646, and 15764.

15546 (CONF-660221-, pp 1-27) RECENT PROGRESS IN FISSION PHYSICS. Ramanna, R. (Atomic Energy Establishment, Trombay (India)).

A brief survey of the theoretical explanation of fission is presented. It is shown that most of the experimental observations on fission can be explained using the collective model, the stochastic model, and the BCS theory. Spontaneous fission, fragment mass distributions, cross sections, deformation energies, and fragment angular distributions are discussed. (D.C.W.)

15547 (CONF-660221-, pp 28-32) THERMAL NEUTRON INDUCED FISSION OF ^{229}Th. Zaghloul, R. (Atomic Energy Establishment, Trombay (India)).

The energy distribution of fission fragments from the thermal neutron fission of ^{229}Th was measured after verifying the purity of the ^{229}Th sample. (D.C.W.)

15548 (CONF-660221-, pp 33-7) ^{239}Pu TERNARY FISSION IN THE RESONANCE REGION. Mehta, G. K. (Indian Inst. of Tech., Kanpur); Melkonian, E. (Columbia Univ., New York).

The neutron fission of ^{239}Pu was investigated in the energy range from the cadmium cut-off to a few keV, in which several resonances with spin 0 and 1 are expected. The yields and kinetic-energy distributions of fission fragments and ternary alpha particles were measured. It was found that the ternary fission probability varies from resonance to resonance and that there is a possible grouping of the resonances according to the two possible spin states. (D.C.W.)

15549 (CONF-660221-, pp 38-42) ANGULAR DISTRIBUTION OF FISSION FRAGMENTS IN BINARY AND TERNARY FISSION OF ^{235}U INDUCED BY 3 MeV NEUTRONS. Nadkarni, D. M. (Atomic Energy Establishment, Trombay (India)).

The angular distributions of fission fragments from the binary and ternary neutron fission of ^{235}U at 3 MeV were measured using a gridded ionization chamber to detect the fission fragments. The anisotropy of the angular distributions was also obtained. The results are consistent with a mechanism of ternary fission in which the alpha particles are evaporated from the neck region of the highly deformed fissioning nucleus with high angular momentum and are therefore peaked in the forward direction with respect to the incident neutrons, which eventually results in 90° peaking of the angular distribution for ternary fission. (D.C.W.)

15550 (CONF-660221-, pp 166-9) PROPERTIES OF THE LOW ENERGY EXCITED STATES OF ^{197}Au. Raju, M. L. N.; Lakshminarayana, V. (Andhra Univ., Waltair (India)).

The low-lying excited states of ^{197}Au were described using particle and particle ($^3/_2$) + phonon functions. For the $^5/_2$ + state, however, an admixture of particle ($^1/_2$) + phonon was necessary to account for the large B(E2) value for the 202-keV transition. (D.C.W.)

15551 (CONF-660221-, pp 184-8) BETA DECAY EXPERIMENTS AND PARITY OF ^{192}Ir. Bhattacherjee, S. K.; Jain, H. C.; Mitra, S. K.; Padhi, H. C. (Tata Inst. of Fundamental Research, Bombay (India)).

Measurements of $\beta-\gamma$ directional correlations were made for two cascades in the decay of ^{192}Ir. It was concluded that the parity of ^{192}Ir is negative and that the ground state of ^{192}Ir has an assignment of 4$^-$. The $\beta-\gamma$ circular polarization was also measured, as was the energy dependence of the anisotropy in the inner beta group. (D.C.W.)

15552 (CONF-660221-, pp 189-91) BETA GAMMA DIRECTIONAL AND CIRCULAR POLARIZATION CORRELATION IN ^{228}Ac. Bhattacherjee, S. K.; Bhatki, K. S.; Ephraim, D. C.; Jain, H. C.; Mitra, S. K.; Padhi, H. C. (Tata Inst. of Fundamental Research, Bombay (India)).

Measurements were made of $\beta-\gamma$ directional correlation and circular polarization in the decay of ^{228}Ac. It was concluded that the parity of ^{228}Ac is negative and that the ground state of ^{228}Ac has an assignment of 3$^-$. (D.C.W.)

15553 (CONF-660221-, pp 192-3) BETA DECAY MATRIX ELEMENTS IN THE DECAY OF ^{111}Ag. Rao, V. Seshagiri; Lakshminarayana, V. (Andhra Univ., Waltair (India)).

Beta-gamma directional correlations were studied in ^{111}Ag for a first-forbidden non-unique beta transition. Integral correlations were performed at five angles, and differential correlations were investigated at five energies. Correlation coefficients were obtained. The matrix elements were calculated from the shape and the $\beta-\gamma$ circular polarization correlations of the beta group considered. (D.C.W.)

15554 (CONF-660221-, pp 194-8) GAMMA-GAMMA DIRECTIONAL CORRELATIONS IN ^{144}Pr. Gupta, S. L.; Saha, N. K. (Delhi Univ. (India)).

The energy levels of ^{144}Pr, particularly the spin and parity of the ground state, were investigated by measuring $\gamma-\gamma$ directional correlations for the 34-100 and 54-80 keV cascades. The results support an assignment of 0$^-$ for the ground state and an E2 multipolarity for the 100-keV transition. (D.C.W.)

15555 (CONF-660221-, pp 199-203) GAMMA-GAMMA DIRECTIONAL CORRELATIONS IN ^{187}Re. Gupta, S. L.; Bajaj, M. M. (Delhi Univ. (India)).

The spin assignments to the 206- and 686-keV levels of ^{187}Re were investigated by measuring $\gamma-\gamma$ directional correlations for the 72-134 and 552-134 keV cascades in ^{187}Re. E2 and M1 transition probabilities were also calculated for the 134-keV radiation; the results show that Nilsson's model for deformed nuclei accounts fairly well for ^{187}Re. (D.C.W.)

15556 (CONF-660221-, pp 204-8) LEVEL STRUCTURE OF ^{199}Au. Prasad, K. G.; Sharma, R. P.; Thosar, B. V. (Tata Inst. of Fundamental Research, Bombay (India)).

The energy levels of ^{199}Au were investigated through the decay of 30-min ^{199}Pt. Gamma spectra and conversion coefficients were measured. The relative intensities of gamma transitions in ^{199}Au were determined; and information on the lifetimes, spins, and transition multipolarities of ^{199}Au levels was obtained. Evidence for a previously unreported level at 324 keV was noted. (D.C.W.)

15557 (CONF-660221-, pp 209-13) ^{92}Nb AND ENERGY LEVELS IN ^{92}Zr. Basu, D.; Sethi, B.; Bakhru, H. (Saha Inst. of Nuclear Physics, Calcutta (India)).

Samples of Nb metal were bombarded with 14.8-MeV neutrons, and the induced β and γ activities were investigated. Cross sections for the reactions ^{93}Nb(n,2n)^{92}Nb, ^{93}Nb(n,γ)^{94}Nb, and ^{93}Nb(n,α)^{90}Y* were determined, as well as the half lives of the product nuclei. A decay scheme is proposed for ^{92}Nb. (D.C.W.)

15558 (CONF-660221-, pp 214-17) DECAY OF ^{174}Tm. Gujrathi, S. C.; Mukherjee, S. K. (Saha Inst. of Nuclear Physics, Calcutta (India)).

The decay of ^{174}Tm was investigated in a series of $\beta-\gamma$ and $\gamma-\gamma$ coincidence experiments. Spin and parity assignments were made to some levels in ^{174}Yb. A decay scheme is proposed for ^{174}Tm. (D.C.W.)

15559 (CONF-660221–, pp 218-21) THE DECAY OF ^{176}Tm AND THE ENERGY LEVELS OF ^{176}Yb. Gujrathi, S. C.; Mukherjee, S. K. (Saha Inst. of Nuclear Physics, Calcutta (India)).

The beta and gamma activities induced in the bombardment of ^{176}Yb with 14.8-neutrons were investigated. Spin-parity assignments were made to the ground state and the 12-sec isomeric state of ^{176}Yb. A decay scheme is proposed for ^{176}Tm. (D.C.W.)

15560 (CONF-660221–, pp 224-7) DECAY OF ^{164}Ho. Sethi, B.; Mukherjee, S. K. (Saha Inst. of Nuclear Physics, Calcutta (India)).

Beta and gamma spectra from the decay of ^{164}Ho were measured, and relative intensities were determined, as were the end-point energies of beta groups. The half lives of the ground and metastable states of ^{164}Ho were obtained, together with the cross sections for the production of these states in (n,2n) reactions. The K conversion coefficients of the 72- and 90-keV transitions of ^{164}Dy and ^{164}Er, respectively, were calculated using the data from $\gamma-\gamma$, $x-\gamma$, and $\beta-\gamma$ coincidence experiments. (D.C.W.)

15561 (CONF-660221–, pp 228-33) ENERGY LEVELS OF ^{149}Pm. Gopinathan, K. P.; Singru, R. M. (Tata Inst. of Fundamental Research, Bombay (India)).

Gamma spectra and conversion-electron spectra from the decay of ^{149}Pm were measured. Relative intensities and transition multipolarities were determined, and information on the lifetimes of some levels was obtained. A level scheme is proposed for ^{149}Pm. (D.C.W.)

15562 (CONF-660221–, pp 234-8) DECAY OF ^{110}Ag. Sud, S. P.; Mangal, P. C.; Trehan, P. N. (Punjab Univ., Chandigarh (India)).

The decay of ^{110m}Ag was investigated using a sum-coincidence technique. The cascades in ^{110}Cd that could account for the observed sum-coincidence spectra were determined. Evidence for a level in ^{110}Cd at 2.72 MeV was obtained. (D.C.W.)

15563 (CONF-660221–, pp 243-6) SUM COINCIDENCE STUDIES OF THE DECAY SCHEMES OF ^{182}Ta AND ^{131}Ba. Murty, V. Radhakrishna; Jnanananda, Swami (Andhra Univ., Waltair (India)).

Sum-coincidence spectra were measured for ^{131}Ba and ^{182}Ta. Some previously unreported transitions in ^{131}Cs and ^{182}W were observed. Level schemes were proposed for ^{131}Cs and ^{182}W. (D.C.W.)

15564 (CONF-660221–, pp 247-50) FRACTIONAL INTENSITIES IN THE DECAY OF ^{177}Lu AND ^{186}Re. Murthy, V. Radhakrishna (Punjab Univ., Chandigarh (India)); Jnanananda, Swami (Andhra Univ., Waltair (India)).

The crossover and cascade fractional intensities of transitions in the decay of ^{177}Lu and ^{186}Re were determined by studying sum and zero-bias sum-peak coincidence spectra and determining the attenuation factors of the peaks at which the sum energies are obtained. Branching ratios and transition probabilities were obtained for levels in ^{177}Hf and ^{186}Os. (D.C.W.)

15565 (CONF-660221–, pp 273-8) STUDY OF NEUTRON RESONANCE PARAMETERS USING SLOWING DOWN TIME LEAD SPECTROMETER. Chandramoleswar, K.; Navalkar, M. P.; Phiske, M. R.; Ramana, J. V.; Ramakrishna, D. V. S.; Sadavarte, S. K. (Atomic Energy Establishment, Trombay (India)).

Some measurements of the neutron resonance parameters of ^{197}Au and ^{109}Ag using a slowing-down-time spectrometer are summarized. The analysis of the data is outlined. (D.C.W.)

15566 (CONF-660221–, pp 307-11) TEMPERATURE DEPENDENT EFFECTIVE MULTIGROUP CAPTURE CROSS SECTION OF THORIUM. Singh, R. Shankar (Atomic Energy Establishment, Trombay (India)).

A computer program DOPOINT that calculates resonance integrals including temperature effects under the narrow resonance approximation was prepared, and resonance integrals for Th were calculated as well as the capture cross section of ^{232}Th at four temperatures. (D.C.W.)

15567 (JINR–P7-3103) O MEKHANIZME DELENIYA YADER NA TRI OSKOLKA V REAKTSIYAKH S TYAZHELYMI IONAMI. (On Mechanism of Ternary Fission in Heavy Ion Reactions). Muzychka, Yu. A.; Oganesyan, Yu. Ts.; Pustyl'nik, B. I.; Flerov, G. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1967. 13p. (In Russian). Dep. mn.

The mechanism of the ternary fission of nuclei in heavy ion reactions is considered. It is shown that at high excitation energy the main deposit into the ternary fission is due to the "cascade" fission, in which the initial nucleus is subjected to the binary asymmetrical fission accompanied by the fission of a heavy fragment. Excitation functions of the cascade fission for the reactions ^{238}U(^{22}Ne,3f), ^{209}Bi(^{40}Ar,3f), and ^{238}U(^{40}Ar,3f) are calculated. (auth)

15568 (JINR–P7-3105) EFFEKTIVNYE MOMENTY INERTSII TYAZHELYKH YADER V SEDLOVOI TOCHKE. (Effective Moments of Heavy Nucleus Inertia in Saddle Point). Karamyan, S. A.; Kuznetsov, I. V.; Muzychka, Yu. A.; Oganesyan, Yu. Ts.; Penionzhkevich, Yu. E.; Pustyl'nik, B. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1967. 30p. (In Russian). Dep. mn.

The angular distribution of the fission fragments produced while bombarding ^{197}Au, ^{209}Bi, and ^{238}U with accelerated ^{12}C, ^{14}N, ^{16}O, and ^{22}Ne ions was measured. The angular dependence of the elastic scattering cross section was measured for each target-particle combination and at each energy of the bombarding ions. It is shown that, within the experimental accuracy, the value of I_{eff} depends only on Z^2/A and does not depend on the angular momentum and the nuclear temperature. (auth)

15569 (NP–16484) ETUDE DE TRANSITIONS DE BASSE ENERGIE DANS QUELQUES ISOTOPES DE LUTECIUM ET D'YTTERBIUM. (Low Energy Transitions in Several Isotopes of Lutetium and Ytterbium). Barneoud, Daniel (Grenoble Univ. (France). Faculte des Sciences). [1965]. 68p. (In French). Dep. mn.

Thesis.

Some low-energy transitions of ^{175}Hf, ^{159}Gd, ^{171}Hf, ^{171}Lu, and ^{170}Lu were studied. A level with spin $\frac{1}{2}$ was found in ^{171}Lu as the ground state of the rotation band of the [541] state in the Nilsson [Nn$_z\Lambda$] configuration. On the contrary it was not possible to show that this configuration exists in ^{175}Lu. The multipolarity of some transitions accompanying the decay of the isotopes ^{175}Hf, ^{171}Hf, and ^{170}Lu were determined or made more precise. It was shown that a semi-empirical correction of the M conversion coefficients makes it possible, beginning with the values tabulated by Rose, to obtain correct values of the conversion coefficients. (J.S.R.)

15570 DETERMINATION OF VERY LOW TRANSITION ENERGY OF ^{235m}U. Mazaki, Hiromasa; Shimizu, Sakae. Bull. Inst. Chem. Res., Kyoto Univ., 44: 394-400(Sept. 1966).

With a specially designed 12-stage secondary electron multiplier, a conventional technique for detection of soft electrons below 100 eV was developed. Applying the retarding method with this multiplier, the transition energy of a nuclear isomer ^{235m}U was determined as to be 30 ± 3 eV. Although there are some restrictions concerning electron sources to be measured, application of the secondary electron multiplier seems to be a useful technique for measurement of soft electrons. (auth)

15571 MEASUREMENT OF ABSOLUTE ACTIVITIES USING THE 4 $\pi\beta\gamma$ COINCIDENCE METHOD IN CASES OF COMPLEX DECAY. Neumann, H. A. (Technische Hochschule, Munich). Atomkernenergie, 11: 477-9(1966). (In German).

A possibility is described for using the 4 $\pi\beta\gamma$ coincidence method to measure absolute activities of isotopes with complex decay. The thermal neutron activation cross section of ^{152}Sm was measured to be σ_{th} = 206 ± 7 barn. (auth)

15572 $\gamma-\gamma$ DIRECTIONAL CORRELATION IN ^{124}Sb. Neumann, Manfred; Lauterjung, Karl Heinz (Univ., Cologne). Z. Phys., 199: 8-24(1967). (In German).

A method is presented to eliminate quantitatively the decay time of the radioactive source and all systematic errors caused by the instability of the associated electronics. The essential part of this procedure is a versatile method to measure the random coincidences together with the sum of true and random coincidences under the same experimental conditions for both quantities. The proposed method is applied to $\gamma-\gamma$-directional correlation measurements with a five-detector apparatus. The construction and function of the device is illustrated. Test measurements with ^{60}Co prove the usefulness of the method and the capability of the apparatus. The investigation of two $\gamma-\gamma$ cascades in the decay of ^{124}Sb gives the following values for the coefficients of the correlation function: 1.69 to 0.603-MeV cascade: A_2 = –0,065 ± 0,003; A_4 = +0,001 ± 0,005 and 2.09- to 0.603-MeV cascade: A_2 = 0,056 ± 0,008; A_4 = +0,006 ± 0,008. (auth)

15573 β-DECAY OF ^{208}Tl. Ostertag, Hermann; Lauterjung, Karl Heinz (Univ., Cologne). Z. Phys., 199: 25-40(1967). (In German).

An iron-free intermediate-image β-ray spectrometer was used to investigate the β decay of ^{208}Tl in coincidence with the 2.615-MeV γ ray of ^{208}Pb. Four β groups were found, three of which were previously known. The fourth group has an endpoint energy of 0.64 ± 0.03 MeV and an intensity of (4.5 ± 1.5)%. It is supposed that this transition is still complex and feeds a group of levels around the known 4.3-MeV level of ^{208}Pb. No β ray of maximum energy 1.032 MeV to the 3.961-MeV level could be found. (auth)

15574 THE (n,γ) CROSS SECTION OF ^{197}Au AT 30 AND 64 keV NEUTRON ENERGY. Poenitz, W. (Kernforschungszentrum, Karlsruhe, Ger.). J. Nucl. Energy, Pt. A and B, 20: 825-34(Oct. 1966).

The neutron capture cross section of ^{197}Au was measured at 30 and 64 keV neutron energy using the activation method. Two different methods were used at 30 keV for the absolute neutron flux determination. The results are $\sigma^{Au}_{n,\gamma}$(30 keV) = (0.600 ± 0.009) and $\sigma^{Au}_{n,\gamma}$(64 keV) = (0.357 ± 0.009). (auth)

15575 COINCIDENCE MEASUREMENTS ON CAPTURE γ RAYS FROM ^{149}Sm. Lang, Johann (Technische Hochschule, Muenchen, Ger.). Z. Naturforsch., 21a: 1729-30(Oct. 1966). (In German).

Coincidence measurements were made on the γ rays following thermal neutron capture by ^{149}Sm. The measurements are consistent with the level schemes reported by Smither at Argonne and by Elze at Munich. A strong ground transition from a previously tentatively assumed level at 737 keV is excluded. (auth)

15576 EXCITATION ENERGY OF THE SPONTANEOUSLY FISSIONING ISOMERIC STATE IN ^{240}Am. Bjoernholm, S. (Univ. of Copenhagen); Borggreen, J.; Westgaard, L.; Karnaukhov, V. A. Nucl. Phys., A95: 513-25(1967).

The excitation function for the reaction ^{241}Pu(p,2n)^{240m}Am leading to the spontaneously fissioning isomeric state in ^{240}Am was measured with proton energies of 9.6 to 13.6 MeV. The excitation function shows a typical threshold behavior, corresponding to a threshold of 10.7 ± 0.1 MeV. This is 3.15 ± 0.25 MeV higher than the estimated threshold for the ground-state reaction, and it is interpreted as the excitation energy of the isomeric state. Possible reasons for the unusual stability towards γ emission of such a high-lying level are discussed. (auth)

15577 POPULATION OF ROTATIONAL AND ISOMERIC STATES IN RARE EARTHS. Jaegare, S. (NORDITA, Copenhagen). Nucl. Phys., A95: 481-90(1967).

Population of ground-state rotational bands and isomeric cross section ratios in doubly even rare earths produced in compound (α,2nγ) and (p,2nγ) reactions are discussed. From comparison with experimental data, spin cutoff parameters are deduced for some isotopes of Sm, Gd, Dy, Er, Yb, and W. (auth)

15578 THE HALF LIFE OF THE 2211-keV STATE IN ^{136}Ba. Fujioka, M.; Miyachi, T.; Adachi, H. (Tokyo Inst. of Tech.). Nucl. Phys., A95: 577-90(1967).

The decay of 12.9-day ^{136}Cs was studied with a delayed coincidence circuit. It was found that the 2211-keV (6^+) state in ^{136}Ba is delayed with respect to the 342-keV beta rays with a half life of 3.3 ± 0.3 nsec, and the half life of the 2144 keV (5^-) state is smaller than about 1 nsec. Gamma rays and conversion electrons were measured with Ge(Li) and Si(Li) detectors to obtain gamma intensities and conversion coefficients of some of the transitions. Transition probabilities of the four transitions de-exciting the 211-keV state are deduced as follows: 0.45 (340 keV, E2), 4.8 (153 keV, E2), 2.2×10^{-6} (176 keV, E1), and 2.7×10^{-5} (67 keV, E1) in Weisskopf units. The excited states in ^{136}Ba are discussed in terms of two-particle excitations on the basis of data thus far obtained in the decay of ^{136}Cs. (auth)

15579 ANGULAR CORRELATION MEASUREMENT OF THE 722 keV TO 556 keV GAMMA-GAMMA CASCADE IN ^{114}Cd. Fricke, K.; Koch, J.; Schoetzig, U.; Muennich, F. (Technische Hochschule, Brunswick). Nucl. Phys., A95: 625-31(1967).

A study of the γγ cascade in ^{114}Cd was performed to clarify conflicting results of measurements for this cascade and their interpretation. From one of these measurements, a decay scheme of ^{114m}In was deduced with an electron-capture branch from the ground state of ^{114}In to the 1.210-MeV, 2^+ state in ^{114}Cd. From the experimental angular correlation coefficients the log ft value of this branch and the E2/M1 mixing ratio of the 2^+-2^+ transition in ^{114}Cd was obtained; the values of both quantities seem to be inconsistent with systematic trends and theoretical predictions. In the present work the values A_2 = +0.1010 ± 0.0015 and A_4 = +0.0097 ± 0.0020 for the angular correlation coefficients were measured, in full agreement with the theoretical values of a pure 4-2-0-cascade. There is no hint to the presence of the electron-capture branch mentioned and the quantities deduced from it. (auth)

15580 DECAY ENERGY OF ^{139}Ce AND LIFETIME OF THE 166-keV LEVEL IN ^{139}La. Marelius, A.; Sparrman, P.; Haeggblund, S.-E. (Uppsala Univ.). Nucl. Phys., A95: 632-8(1967).

The K-capture probability of the electron capture decay of ^{139}Ce was measured by Auger electron–conversion electron coincidence technique to be 0.68 ± 0.02, and the decay energy was calculated to be 85 ± 4 keV. The lifetime of the 166-keV level in ^{139}La was measured to be 1.48 ± 0.03 nsec. (auth)

15581 NUCLEAR MAGNETIC MOMENTS OF THE FIRST AND THE SECOND EXCITED STATES IN ^{127}I. Svensson, A. G.; Sommerfeldt, R. W.; Norlin, L.-O.; Tandon, P. N. (Uppsala Univ.). Nucl. Phys., A95: 653-62(1967).

By means of the method of perturbed angular correlations, the nuclear magnetic moments of the 58-keV and the 203-keV states in ^{127}I are investigated. The first moment is found to be μ_{58} = 2.02 ± 0.15 nm, and for the latter moment 1.07 nm is the lower limit. The lifetimes of the levels are measured to be τ_{58} = 2.79 ± 0.10 nsec and τ_{203} = 0.47 ± 0.03 nsec. The results are compared to the predictions by Kisslinger and Sorensen. (auth)

15582 GAMMA RAYS EMITTED IN DISINTEGRATION OF ^{192}Ir AND ^{194}Ir. Palaska, T. J.; Potnis, V. R.; Mandeville, C. E. (Kansas State Univ., Manhattan). Nucl. Phys., A95: 673-82 (1967).

The gamma rays emitted in disintegration of ^{192}Ir and ^{194}Ir were studied in a Ge(Li) detector having a depletion layer thickness of 4.2 mm. Quantum energies and relative intensities were obtained. Sixteen gamma rays, previously reported to be emitted in the decay of ^{192}Ir, were not observed. A previously undetected gamma ray at 589 keV was observed in the disintegration of ^{194}Ir. Modifications in the various modes of de-excitation of the residual nuclei ^{192}Os, ^{192}Pt, and ^{194}Pt are proposed. (auth)

15583 NEUTRON CROSS SECTIONS OF Pr, Yb, Lu, Er, Ho, AND Tm. Zimmerman, R. L.; Amaral, L. Q.; Fulfaro, R.; Mattos, M. C.; Abreu, M.; Stasiulevicius, R. (Instituto de Energia Atomica, Sao Paulo, Brazil). Nucl. Phys., A95: 683-93 (1967).

The total neutron cross sections of Pr, Yb, Lu, Er, Ho, and Tm were measured by transmission within the neutron energy range 0.001 to 1.0 eV, with special attention given to obtain values at the thermal energy 0.025 eV. A crystal spectrometer coupled with a mechanical monochromator and a slow chopper were used at the swimming pool research reactor of the Instituto de Energia Atômica. Powder samples of the oxides were supplied in high purity with particular care to eliminate contamination by the rare earths which have high neutron cross section. The data were analyzed to determine the nuclear absorption and nuclear scattering cross sections. Effects of nuclear resonances and of the atomic paramagnetic scattering were considered. In the case of Lu, the parameters of the first resonance are presented. In the cases of Tm and Ho, experimental values of the paramagnetic scattering cross sections are compared with those expected from calculated electronic wave functions. (auth)

15584 METHOD OF CORRECTION FOR UNRESOLVED LEVELS IN FISSILE NUCLEI. Musgrove, A. R. (Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Austral. J. Phys., 20: 73-9(Feb. 1967).

A method of correcting for unresolved levels in fissile nuclei is described. The method is based on the distribution of the ratio of the reduced neutron width to the total width of a level. Calculations are carried out on three sets of data for ^{233}U, and it is shown that approximately 25% of the resonance levels are undetected. (auth)

15585 ON THE MAGNETIC PROPERTIES OF THE ^{171}Tm NUCLEUS. Bochnacki, Z. (Joint Inst. for Nuclear Research, Dubna, USSR); Ogaza, S. Acta Phys. Pol., 31: 51-5(Jan. 1967).

The available experimental data on the magnetic properties of the ground state K = ½ rotational band of the ^{171}Tm nucleus are analyzed in terms of the effective spin g-factors. It is shown that these data can be explained by taking into account a spin polarization of the even core by the odd proton, if the transverse spin polarization is different from the longitudinal polarization. (auth)

15586 CIRCULAR POLARIZATION OF γ QUANTA FROM ^{181}Ta. Lobashov, V. M.; Nazarenko, V. A.; Saenko, L. F.; Smotritskii, L. M.; Kharkevich, G. I. (Ioffe Inst. of Physics and Tech., Leningrad). JETP Lett. (USSR) (Engl. Transl.), 5: 59-61(Jan. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 73-5(Jan. 15, 1967).

The circular polarization of the 482-keV gamma rays from ^{181}Ta was measured in order to study the admixture of weak nucleon-nucleon interaction in nuclear processes. (D.C.W.)

15587 FRAGMENT ANGULAR DISTRIBUTION IN THE FISSION OF ^{232}Th BY 1.6-MeV NEUTRONS. Ermagambetov, S. B.; Smirenkina, L. D.; Smirenkin, G. N.; Tishin, A. S. JETP Lett. (USSR) (Engl. Transl.), 5: 30-3(Jan. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 39-44(Jan. 1, 1967).

The results of accurate and detailed measurements of the angular distribution of fragments from the ^{232}Th(n,f) reaction at E_n = 1.60 ± 0.02 MeV are presented. The measurements were made with an electrostatic generator by registering the fission fragments in glass. The data are compared with those obtained by other investigators. (S.F.L.)

15588 STUDY OF THE PHOTOGRAPHIC BLACKENING GAIN DUE TO THE ACCELERATION OF CONVERSION ELEC-

TRONS BY THE METHODS OF PREACCELERATION OR OF POSTACCELERATION IN A 180° SPECTROGRAPH. CASE OF THE SIMULTANEOUS USE OF THE TWO METHODS. Gautier, Francoise (Centre National de la Recherche Scientifique, Essonne, France). Compt. Rend., Ser. B., 263: 1411-14(Dec. 19, 1966). (In French).

In a semicircular spectrograph with photographic detection, preacceleration and a postacceleration was applied to Auger electrons and internal conversion electrons of ^{227}Th and of ^{228}Th (8 keV < E < 250 keV). The blackening gain obtained by each method was calculated, and it was shown that the simultaneous use of these two methods permits the obtainment of a considerable gain at low energy. (tr-auth)

15589 SHORT-LIVED NEUTRON-DEFICIENT OSMIUM ISOMER. Aten, A. H. W. Jr.; Kapteyn, J. C. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Physica, 32: 1808-12 (Oct. 1966).

The osmium fraction, obtained from rhenium irradiated with high-energy protons, contains a 2.8-min activity, which consists of K radiation, combined with γ rays and possibly positons. This activity is almost certainly due to an osmium isomer and most likely to an isomer of a neutron-deficient isotope. (auth)

15590 INVESTIGATION OF DELAYED NEUTRON PRECURSORS OF As, Sb, AND Ge. del Marmol, P.; Neve de Mevergnies, M. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). J. Inorg. Nucl. Chem., 29: 273-9(Feb. 1967).

As, Sb and Ge may be separated in a few seconds as hydrides from the bulk of the thermal neutron fission products of ^{235}U. A 2.15 ± 0.15 sec delayed neutron half life is observed contributing 4% to the total yield of delayed neutrons formed in fission. It is assigned to ^{85}As as delayed neutron precursor, with a neutron emission probability of 11 ± 3%, on the grounds of the fine structure of the fission mass-yield curve. ^{87}As is excluded, its half life being ≤ 1.5 sec. An upper limit to any contribution of an Sb delayed neutron precursor to this activity is 25%. A 10 ± 2 sec delayed neutron half life observed under the same conditions is discussed and cannot be attributed to these elements. (auth)

15591 GAMMA RAY TRANSITIONS IN ^{144}Pr. Loevhoiden, G.; Tjoem, P. O. (Oslo Univ.). Phys. Norv., 1: 281-4 ([1965]).

The gamma transitions in ^{144}Pr following the beta decay of ^{144}Ce were studied by use of a lithium-drifted germanium detector. The results confirm the level structure deduced by Iwashita et al. (1963), but three previously unreported gamma transitions were observed with energies of 74, 86, 107 keV. Indications of two other levels at 131 and 121 keV were noted. The relative intensities of the gamma transitions are given. (auth)

15592 THE THERMAL NEUTRON CROSS SECTIONS AND RESONANCE INTEGRALS OF ^{139}La AND ^{140}La. O'Brien, H. A.; Eldridge, J. S.; Druschel, R. E.; Halperin, J. (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem., 29: 584-7(Feb. 1967). (ORNL-P-2504).

Both ^{139}La and ^{140}La are produced by fission with high yields in a nuclear reactor, and their cross sections are of interest to the neutron economy of a reactor system. Also, relatively intense ^{141}Ce sources, essentially carrier-free, can be prepared by irradiating ^{139}La in a high-flux reactor. The experimental procedure and calculations for measuring the cross sections and resonance integrals are described (employing La_2O_3). A thermal cross section of 2.7 ± 0.3 barns and a resonance integral of 69 ± 4 barns are reported for ^{140}La. Calculated values of the 2,200 m/s cross section and resonance integral for ^{139}La are 9.5 ± 0.5 barns and 11.2 ± 0.6 barns, respectively, which is consistent with the results of other measurements. (auth)

15593 THE DECAY OF ^{249}Cf. Kool, J.; Wapstra, A. H. J. Inorg. Nucl. Chem., 29: 293-7(Feb. 1967).

Pure ^{249}Cf was obtained by milking from a ^{249}Bk sample previously purified from all contaminants. The gamma spectrum was measured, and the results were used to derive more accurate values for the level energies in the daughter ^{245}Cm. (auth)

15594 THE ROTATIONAL STATES OF ^{184}Os, ^{186}Os, AND ^{188}Os. Newton, J. O.; Stephens, F. S.; Diamond, R. M. (Univ. of California, Berkeley). Contract W-7405-eng-48. Nucl. Phys., A95: 377-84(1967). (UCRL-17205).

Gamma rays following the (^{4}He,2n) reactions leading to the nuclei ^{184}Os, ^{186}Os, and ^{188}Os were studied. Unambiguous assignments were made for the 6^+ states, strong assignments for the 8^+ states, and tentative assignments for the 10^+ states of the ground-state rotational bands in these nuclei. (auth)

15595 ANGULAR DISTRIBUTIONS OF GAMMA RAYS PRODUCED IN REACTIONS WITH HEAVY IONS. Newton, J. O.; Stephens, F. S.; Diamond, R. M.; Kotajima, K.; Matthias, E. (Univ. of California, Berkeley). Contract W-7405-eng-48. Nucl. Phys., A95: 357-76(1967). (UCRL-17204).

Angular distributions of the stretched E2 gamma transitions cascading from rotational or vibrational states, populated by heavy-ion, xn reactions were measured. The reactions were induced by ^{4}He, ^{11}B, ^{14}N, and ^{19}F ions on targets in the mass range from 159 to 186. In one case the variation of anisotropy with bombarding energy was measured. Large anisotropies were observed indicating the strong alignments of the decaying states. The problems involved in a theoretical calculation of the alignments are discussed. The implications of the strong angular distributions for nuclear structure measurements with these reactions are considered. (auth)

15596 DIRECT-INTERACTION PROTONS EMITTED FROM Ag AND Au TARGETS BOMBARDED WITH 91- AND 156-MeV PROTONS. Brun, C.; Dubost, H.; Gatty, B.; Lefort, M.; Tarrago, X. (Univ., Paris, Orsay, France). Nucl. Phys., A95: 337-56(1967). (In French).

Angular and energy distributions were measured for prompt protons emitted between 4 and 150 MeV after the bombardment of Ag and Au targets by 156- and 91-MeV protons. The experimental device is a telescope made of 4 dE/dx and E solid-state counters. The energy distributions obtained in the forward angles are compared with the results obtained after Monte-Carlo calculations on a large number of nucleon-nucleon quasi-elastic collisions inside the nuclear matter. Three models were used in the calculation; the impulse approximation was assumed for all three. One model is based on a square well potential. Both model 2 and model 3 assume a diffuse-edge nucleus. Model 2 (step) takes account of transmission coefficients by a classical refraction approximation. Model 3 (step no) does not include any effect of refraction or reflection. The comparison with experimental data shows that prompt cascade protons are emitted at a large rate even for an incident energy of 91 MeV. The proportion of compound nucleus is much lower than the calculated value by model 2. In many respects the best fit seems to be obtained with model 3, so called "step no." The complete set of experimental data might stimulate more elaborated calculations on the direct process. (auth)

15597 EVALUATION OF LIFETIME MEASUREMENTS ACCORDING TO THE METHOD OF DELAYED COINCIDENCES. Richter, F. W.; Schuett, J. (Univ., Marburg, Ger.). Z. Phys., 199: 422-32(1967). (In German).

The various methods of evaluating delayed $\gamma-\gamma$ coincidence time spectra are discussed and are used to determine the half life of the 81-keV level in ^{133}Cs. A value of 6.25 ± 0.05 nsec was obtained. It is shown that in the case of a momentum analysis of background subtracted and strongly asymmetric time spectra, one has to extrapolate the measured time spectrum in order to get consistent results. (auth)

15598 ELASTIC SCATTERING OF 55-MeV PROTONS FROM HEAVY NUCLEI. Kamitsubo, H.; Ohnuma, H.; Ono, K.; Uchida, A.; Imaizumi, M.; Kobayashi, S.; Sekiguchi, M. (Tokyo Univ.). J. Phys. Soc. Jap., 22: 19-28(Jan. 1967).

Several targets covering the spherical, deformed, and transition regions of heavy nuclei were bombarded with 55-MeV protons, and angular distributions of the elastically scattered protons were measured. The diffraction structure is strongly damped for the deformed nuclei, as compared with that for the spherical nuclei; this feature changes gradually for nuclei of the transition region. An optical model analysis was also performed to discuss the details of the deformation effect. (auth)

15599 STUDY OF RESONANCE ABSORPTION AND INTERFERENCE BETWEEN RESONANCES OF ^{115}In, GOLD, AND ^{185}Re. Brown, Harry Liber Jr. Stanford, Calif., Stanford Univ., 1966. 170p.

Thesis.

Experiments using uranium and thorium, which have relatively complex resonance structures, do not afford an unambiguous experimental check for the calculation of resonance integrals. Therefore, isotopes with a single predominant resonance were studied. These included ^{115}In, Au, and ^{185}Re. The experiments described have two primary objectives. First, the most recent resonance integral theory of Nordheim, which still contains a few basic assumptions, was investigated and tested against experimental results. The second objective was to determine the effect of one resonance absorber upon another. This effect was termed "interference." Resonance integrals of single absorber samples were measured by means of an activation technique in the Stanford Pool Reactor. In this study, the diluent was varied from one of very little moderating power (lead) to one of strong moderating power (hydrogen) over a wide range of absorber concentrations. The effective scattering cross section per absorber atom, σ_p^*, was var-

ied from 181 to 11796, 118 to 1480, 566 to 8644 b for ^{115}In, Au, and ^{185}Re respectively. The experimental results of ^{115}In and Au were in good agreement with the results predicted by the Nordheim approach (ZUT code). The ^{185}Re study showed substantial disparity between experiments and ZUT calculations. Since there was a significant difference between the ^{185}Re resonance parameters reported in BNL-325 First Edition (1955) and Second Edition (1958), and between the results of this study and that reported in the literature, a need for re-examination of Re resonance parameters and previous measurements of rhenium resonance integrals is needed. The infinite-dilution resonance integral values of ^{115}In (54-min activity) and ^{185}Re, adjusted to a cutoff energy of 0.5 eV, and including the 1/v contribution, was measured as 2610 ± 78 b and 1666 ± 83 b, respectively. The ^{115}In value agrees well with those in the literature. (Dissertation Abstr.)

15600 NUCLEAR STRUCTURE OF ^{177}Hf, ^{179}Hf, AND ^{181}Hf. Rickey, Frank Atkinson Jr. Tallahassee, Florida State Univ., 1966. 132p.

Thesis.

Studies of the nuclear levels in ^{181}Hf, ^{179}Hf, and ^{177}Hf were performed by use of the reactions ^{180}Hf(d,p)^{181}Hf, ^{180}Hf(d,t)^{179}Hf, ^{178}Hf (d,t)^{177}Hf, and ^{176}Hf(d,p)^{177}Hf at incident deuteron energies of 10 to 12 MeV. The emergent particles were analyzed in a broad-range magnetic spectrograph. Angular distributions were measured for the reactions ^{180}Hf(d,p)^{181}Hf, ^{178}Hf(d,t)^{177}Hf, and ^{176}Hf(d,p)^{177}Hf and were interpreted with the aid of DWBA theory. l-values were assigned, and spectroscopic factors were extracted. The assignment of l-values has resulted in the interpretation of the structure of ^{181}Hf and ^{177}Hf up to 2 MeV. The (d,t) study of ^{179}Hf was used in conjunction with previously reported (d,p) data, and resulted in an extension of the previous analysis. Nilsson states identified in one or more nuclei are the 9/2 + [633], 1/2 − [521], 5/2 − [512], 7/2 − [514], 9/2 + [624], 1/2 − [510], 3/2 − [512], 7/2 − [503], 5/2 − [501], and 5/2 − [503] states. Speculations were made concerning the observation of vibrational states. (Dissertation Abstr.)

15601 BREMSSTRAHLUNG YIELD FROM BETA EMITTERS. Truscello, Vincent Carl. College Park, Md., Univ. of Maryland, 1966. 87p.

Thesis.

The bremsstrahlung from the beta-emitting radionuclides ^{32}P, ^{204}Tl, ^{45}Ca, and ^{147}Pm were measured and compared with the values calculated from theoretical equations. The main objective was to devise a widely applicable semi-empirical relation between the external bremsstrahlung yield, beta energy distribution, and composition of the absorber. As a result of the external bremsstrahlung experiments, measurements of the inner bremsstrahlung were obtained. These also were compared to theory and fitted to a semi-empirical equation. Thin point-sources of the nuclides were used in conjunction with nuclear pulse height spectrometric techniques to obtain the bremsstrahlung spectra in targets with atomic numbers up to 73 and mass thicknesses up to the maximum range of the beta particle. The results of the experiments were correlated with those expected from thick target bremsstrahlung theory. It was found that the calculated yield "constant" varied with the beta energy, in accord with the more refined theoretical considerations. The "constant" was found to be a monotonically decreasing function of the beta energy. This functional relationship, when compared with a similar one developed from Berger's theoretical treatment, exhibited an identical trend but differed in magnitude by a factor of 2.8. The semi-empirical equations are as follow: $I_{in}(MeV/Beta) = (1.92 - 0.44 \log_{10} E_{rms}) E_{rms}^2 + 3.4 \times 10^{-7} Z_\beta$ and $I_{ex}(MeV/Beta) = (3.35 - 3.25 \log_{10} E_{rms}) E_{rms}^2 Z$. These equations define the inner (I_{in}) and outer (I_{ex}) bremsstrahlung in terms of the root mean square beta energy (E_{rms}), the atomic number of the emitter (Z_β), and the atomic number of the absorber (Z). They can be used to predict total bremsstrahlung yields for radionuclides with beta end point energies in the range 0.1 to 3 MeV. Root mean square energies of a wide variety of beta emitters have been calculated from beta decay theory for use with these equations. (Diss. Abstr.)

15602 MICROCALORIMETRIC DETERMINATION OF THE MEAN β ENERGY OF (^{90}Sr + ^{90}Y). Ramthun, H. (Physikalisch-Technische Bundesanstalt, Brunswick). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/58, 14p. (CONF-661012-42). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

The mean beta-particle energy of an equilibrium mixture of ^{90}Sr and ^{90}Y was measured using a twin microcalorimeter. A mean particle energy of 1.147 MeV/disintegration was obtained. (D.C.W.)

15603 EXACT DETERMINATION OF THE HALF-LIVES OF VARIOUS RADIONUCLIDES. Lagoutine, F.; Le Gallic, Y.; Legrand, J. (CEN de Saclay, Gif-sur-Yvette, France). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/50, 16p. (In French). (CONF-661012-37). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

The half lives of ^{133}Ba, ^{51}Cr, ^{125}I, ^{54}Mn, ^{203}Hg, ^{95}Nb, and ^{204}Tl were measured using the following three methods concurrently: differential ionization chambers with an automatic measuring device, proportional 4π β counting, and a γ scintillation spectrometer with gain stabilization. Particular attention was paid to the determination of statistical and systematic errors. (D.C.W.)

15604 REACTION n,nf AND DELAYED NEUTRON YIELDS. Maksyutenko, B. P. (Inst. of Physics and Energetics, Obninsk, USSR). Vienna, International Atomic Energy Agency, 1966, Preprint No. CN-23/102, 8p. (In Russian). (CONF-661014-37). DTIE.

From IAEA Conference on Nuclear Data, Paris.

The effect of the (n,nf) reaction on the yield ratio of delayed-neutron groups was studied. The experiments were carried out on a Van de Graaff generator. A solid zirconium/deuterium target of thickness 20 mg/cm^2 was used. The maximum energies of the neutron spectrum were in the 5 to 7.75 MeV range. The decay curves were analyzed on a digital computer for given values of half life − 55, 24, 15.5, 5.2, and 2.2 sec. Errors were calculated according to the inverse matrix by the normal method. The two elements which have so far been studied in most detail are ^{238}U (7 points in the above-mentioned energy range) and ^{232}Th (9 points). The results are presented in the form of the ratio of the i-th group of delayed neutrons to the first group (half life 55 sec). The way in which this ratio varies as the energy increases is the same in both elements (for corresponding groups). In both cases the ratio of the yield from each of the groups with half lives of 24 and 5.2 sec, in the energy region where the (n,nf) reaction occurs, has the shape of a resonance curve. The ratio of the 15.5 sec group to the first group shows a clearly defined minimum, while the ratio of the 2.2-sec group shows a more complex structure with maxima and minima; this is possibly due to the fact that it is a mixture of the two groups. (auth)

15605 NUCLEAR STRUCTURE STUDIES WITH (t,p) REACTIONS. Hinds, S. 21p. (CONF-660633-12). DTIE. Gmelin, AED-CONF-66-199-29.

From American Physical Society, Division of Plasma Physics, Minneapolis.

Some experimental observations on states of ^{42}Ca, ^{44}Ca, ^{46}Ca, ^{50}Ca, ^{206}Pb, ^{208}Pb, ^{123}Sb, ^{146}Sm, ^{150}Sm, ^{152}Sm, ^{154}Sm, ^{34}S, ^{36}S, and ^{120}Sn from (t,p) reactions are discussed including the analysis of the experimental angular distributions and spectra. It is concluded that two-nucleon stripping is a valuable spectroscopic tool, but is not as precise as (d,p) observations. (D.C.W.)

Nuclear Theory

Refer also to abstracts 15292, 15488, 15491, 15496, 15500, 15501, 15514, 15517, 15535, 15545, 15546, 15550, 15567, 15598, and 15646.

15606 (BNL-10992) COMBINED USE OF NEUTRON CAPTURE AND CHARGED PARTICLE REACTIONS. Schult, O. W. B. (Technische Hochschule, Munich (West Germany). Brookhaven National Lab., Upton, N. Y.); Sheline, R. K. (Florida State Univ., Tallahassee). [1966]. Contract AT-30-2-GEN-16. 7p. (CONF-661113-2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Slow-Neutron Capture Gamma-Ray Conference, Argonne, Ill.

A brief review is given of the combined use of neutron-capture and charged-particle reactions for the investigation of nuclear energy levels. Examples are given for energy levels of ^{162}Dy, ^{163}Dy, ^{166}Dy, and ^{104}Rh. (S.F.L.)

15607 (BNL-10995) ABSOLUTE OR RELATIVE (n,γ)-DATA? Schult, O. W. B. (Technische Hochschule, Munich (West Germany). Brookhaven National Lab., Upton, N. Y.). [1965]. Contract AT (30-2)-Gen-16. 7p. (CONF-661113-4). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Slow-Neutron Capture Gamma-Ray Conference, Argonne, Ill.

The determination of relative (n,γ) energies with the maximum possible precision is of interest for the construction of nuclear level schemes. Very precise absolute energies seem to be considerably less important. The presentation of relative energies does not require the introduction of new units or energy standards and the maximum precision which has been obtained with the spectrometer is retained in the data. The relative energies should, however, not be completely arbitrary but they should agree with

absolute energies (in keV) within a reasonably high accuracy. Methods are discussed which permit the determination of relative and absolute (n,γ) intensities in the low energy region with the highest possible accuracy. (auth)

15608 (BNL-10996) ON THE CONSTRUCTION OF NUCLEAR LEVEL SCHEMES USING PRECISE RELATIVE (n,γ)-ENERGIES. Schult, O. W. B. (Technische Hochschule, Munich (West Germany). Brookhaven National Lab., Upton, N. Y.). [1966]. Contract AT (30-2)-Gen-16. 7p. (CONF-661113-5). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Slow-Neutron Capture Gamma-Ray Conference, Argonne, Ill.

The application of the Ritz energy combination principle in order to find nuclear levels yields reliable combinations even in cases where the number of (n,γ) transitions is very large, if a subset of intense γ-lines is used. An example is considered and it is shown that the chances to find levels by accident are in this case between 26% and 8×10^{-7}%. The possibility of finding a level by accident is considerable if many levels are present to which transitions may lead. An improvement in relative energy accuracy strongly reduces the chance to obtain by accident a state which is deexcited through many transitions. The knowledge of multipolarities can further aid to reduce the chance for accidental combinations. (auth)

15609 (CONF-660221–, pp 43-55) STATISTICAL THEORIES OF THE NUCLEAR CROSS SECTIONS. Ullah, Nazakat (Tata Inst. of Fundamental Research, Bombay (India)).

The statistical theory is used to study the average properties of compound nuclei and the fluctuations of the reaction cross sections. Several formalisms are briefly discussed, as is the nuclear spectroscopic information that can be obtained by using the statistical model. (D.C.W.)

15610 (CONF-660221–, pp 104-9) STUDY OF NUCLEON CORRELATION WITH TWO PARTICLE STRIPPING REACTION. Mukherjee, Paresh (Saha Inst. of Nuclear Physics, Calcutta (India)).

The use of two-nucleon-transfer reactions in nuclear spectroscopy is briefly discussed. The limitations in the theoretical understanding of the reaction mechanism are outlined. Testing of the highly correlated wave functions for the 0^+ ground state of even-even nuclei as given by various nuclear models, the preferential excitation of certain definite isobaric spin states, testing of the charge-independence hypothesis, and determination of the phases of the different components of the nuclear wave functions are considered. (D.C.W.)

15611 (CONF-660221–, pp 132-9) THREE-BODY SYSTEMS THROUGH FACTORABLE POTENTIALS. Mitra, A. N. (Delhi Univ. (India)).

The treatment of three-body systems using factorable potentials is briefly discussed, including some studies of important three-nucleon parameters. (D.C.W.)

15612 (CONF-660221–, pp 146-9) EFFECTIVE RESIDUAL INTERACTION FOR SHELL MODEL CALCULATIONS. Pandharipande, V. R. (Tata Inst. of Fundamental Research, Bombay (India)).

An interaction which can reproduce the energy-level spectra of ^{42}Ca, ^{18}O, ^{90}Zr, and ^{92}Zr as states of $f_{\frac{7}{2}}$, $d_{\frac{5}{2}}^2$, $g_{\frac{9}{2}}^2$, and $p_{\frac{1}{2}}^2$, respectively, is described; and the results of calculations of the level spectrum of ^{118}Sn using this interaction are presented. (D.C.W.)

15613 (CONF-660221–, pp 171-5) SEMI-EMPIRICAL TERMS IN NUCLEAR POTENTIALS. Sood, Naresh K.; Bedi, Santosh S. (Punjab Univ., Chandigarh (India)).

The neutron and proton well depths for even-even isotopes of Mo, Te, and Sn were studied using a velocity-dependent potential. Expressions for the well depths containing semi-empirical terms were derived. (D.C.W.)

15614 (CONF-660221–, pp 177-80) MAGNETIC MOMENTS OF VIBRATIONAL STATES IN EVEN-EVEN NUCLEI. Bhattacharjee, S. K. (Tata Inst. of Fundamental Research, Bombay (India)).

The gyromagnetic ratios of the vibrational states of even-even nuclei were studied. The experimental values for the known 2^+ vibrational states were plotted as a function of mass. The results indicate that the existing microscopic models of vibrations in spherical nuclei are inadequate to explain the observed gyromagnetic ratios. (D.C.W.)

15615 (CONF-660221–, pp 255-9) NON-RESONANT ELASTIC SCATTERING OF GAMMA RAYS. Singh, M.; Anand, S.; Sood, B. S. (Punjab Univ., Chandigarh (India)).

It is shown that the nonresonant scattering cross section for low-energy gamma rays can be calculated using the Z-dependence for elastic scattering. Some results for nonresonant scattering of 1.12-MeV gamma rays by Pb, Pt, Ta, and Sn are presented and are compared with experimental results. (D.C.W.)

15616 (LYCEN-6638) ETUDE DE CERTAINS TYPES DE REACTIONS (n,α) PAR LA METHODE DES ONDES DISTORDUES. (Studies of Certain Types of (n,α) Reactions by Wave Distortion Method). Fayard, Claude (Lyon Univ., France). Institut de Physique Nucleaire). May 1966. 116p. (In French). Dep. mn.

Thesis.

Neutron reactions (n,α) were studied within the framework of the distorted-wave Born approximation in which the incident and emergent plane waves of the Butler–Born approximation are replaced by distorted waves drawn from the term analysis of the optical model of elastic scattering at energies corresponding to those put in play during the reaction. An attempt was made to consider only one type of substructure in the target nucleus by supposing that this nucleus was formed of a C core to which an α particle was bound. The results obtained were applied to the study of the ^{16}O(n,α)^{13}C reaction. The examination of the angular distribution curves of the (n,α) reaction lead to the conclusion of a direct interaction process. (J.S.R.)

15617 (NP-16587) REPRESENTATION OF THE FINITE ROTATION MATRIX AS A SUM OVER CLEBSCH–GORDAN COEFFICIENTS. Marinov, M. S. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1966. 8p. Dep. mn.

The finite rotation matrix for angular momentum j is decomposed over Clebsch-Gordan matrices representing a complete orthonormalized set of $(2j + 1) \times (2j + 1)$ matrices. The coefficients are found to be proportional to $Y^{(k)}(\underline{n})(i \sin \frac{1}{2}\phi)^{\kappa} C_{2j-k}^{(k+1)}$ $(\cos \frac{1}{2}\phi)$(k = 0, . . ., 2j), where ϕ and $\underline{n}$ are the rotation angle and axis and C_2 is the Gegenbauer polynomial. (auth)

15618 (ORO-1316-28) NUCLEON–NUCLEON BREMSSTRAHLUNG. Pearce, William A.; Gale, William A.; Duck, Ian M. (Rice Univ., Houston, Tex.). Feb. 7, 1967. Contract AT(40-1)-1316. 20p. (CONF-670302-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From American Physical Society, Nucleon–Nucleon Interaction Conference, Gainesville, Fla.

Cross sections for bremsstrahlung production in N-N interactions were calculated using the Tabakin separable potentials. The results were compared with experimental observations. (D.C.W.)

15619 (UCRL-50164) AVAILABLE DISINTEGRATION ENERGY OF ALL RADIONUCLIDES (FOR USE IN DOSIMETRY PROBLEMS). I. HALF-LIVES 12 HOURS OR GREATER. Burton, C. Ann.; Maxwell, Joan H. (California Univ., Livermore. Lawrence Radiation Lab.). Dec. 15, 1966. Contract W-7405-eng-48. 34p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The ERPD computer program calculates the maximum available energy per disintegration for all radionuclides. The input and the results are given for nuclides with half lives greater than 12 hours. (auth)

15620 SELF-CONSISTENT POTENTIAL FOR INDIVIDUAL PARTICLE MOTIONS IN THE NUCLEI WITH CLOSED SHELLS. Wada, Yasushi (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 275-84(1966).

The principle of mass renormalization in the quantum electrodynamics is applied to derive the equations which the potential for the individual particle motions satisfies self-consistently in the nuclei with the doubly closed shells. The potential is to be such that the excitation energy of each single particle (hole) state is invariant when the residual interactions are taken into account. Since this condition is concerned only with the diagonal matrix elements of the potential, the other matrix elements are so determined that the wave functions of the unperturbed ground and single particle (hole) states can best simulate the corresponding perturbed ones. The perturbed ground state is supposed not to have the components with one (particle and hole) pair excitation. Each perturbed single particle (hole) state should have the components of the different unperturbed single particle (hole) states as small as possible. The equations for the potential are given in a form of power series expansion with respect to the two-body interactions and are explicitly written up to the second order. The result turns out to be practically identical with that for the real part of the optical potential. The relation with Sawada's theory in an infinite system is pointed out. (auth)

15621 TOWARD A SELF-CONSISTENT THEORY OF THE NUCLEAR COLLECTIVE HAMILTONIAN. Johnson, Robert E.; Klein, Abraham (Univ. of Pennsylvania, Philadelphia). Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 211-33(1966). (NYO-2171-207).

A new approach to the problem of nuclear vibrational motion, based on the generalized Hartree-Fock approximation of Klein and Kerman is presented. The power of this method for obtaining re-

sults free of cranking concepts is demonstrated by a completely microscopic derivation of a one-dimensional version of Bohr's collective Hamiltonian for vibrations (in the harmonic approximation). The calculation of the moment of inertia of a plane rotator is repeated first to demonstrate how the methods can be used to treat rotations and vibrations on the same footing. Therefore, a general theory for describing the usual types of collective motion in heavy nuclei was obtained. (auth)

15622 BETA-GAMMA ANGULAR CORRELATIONS AND BETA-RAY ANGULAR DISTRIBUTIONS. Morita, Masato; Morita, Reiko (Osaka Univ.). Progr. Theoret. Phys. (Kyoto), Suppl., Nos. 37-38, 458-72(1966).

Formulas for beta-gamma angular correlations in unoriented nuclei and for beta-ray angular distributions in oriented nuclei are collected. Rules are also stated to derive formulas for alpha particles and gamma rays from those for beta particles. (auth)

15623 ANGULAR BETA-RAY BACK-SCATTERING. Szepke, Ryszard (Inst. of Nuclear Research, Warsaw). Nukleonika, 11: 821-5(1966).

For beta back-scattering investigation a special back-scattering and detecting device with an end-window G-M tube was employed. The G-M counter was tested for statistical reliability before the investigation. With this device the angular distribution of back-scattered betas from different materials was observed. There were also studied influences of incident- and reflection-angles on errors of determining of coating thickness. For the study ^{147}Pr, ^{204}Tl and $^{90}Sr + ^{90}Y$ sources were used, but the results are presented for strontium-90 only. (auth)

15624 POPULATION AND DECAY OF HIGH ANGULAR MOMENTUM STATES IN HEAVY ION REACTIONS. Jaegare, S. (NORDITA, Copenhagen). Nucl. Phys., A95: 491-504(1967).

Spin distributions in compound-nuclear reactions initiated by heavy ions on nuclei in the rare-earth region are investigated using the statistical model. A study of the competition between charged particle and neutron emission and between fission and neutron emission shows that the highest angular momentum states which are populated, decay predominantly by the emission of alpha particles. As a result, the spin distributions in the final nuclei are approximately unaffected when the heavy ion energies are increased. (auth)

15625 MANY-PARTICLE SYSTEMS. IV. SHORT-RANGE INTERACTIONS. Hall, R. L.; Post, H. R. (London Univ.). Proc. Phys. Soc. (London), 90: 381-96(Feb. 1967).

A method by Post [Proc. Phys. Soc., A, 69: 936-8(1956) and A, 79: 819-20(1962)], which has been used to calculate lower bounds on the energies of the lowest spatially symmetric or antisymmetric states of identical-particle systems, is shown to apply quite generally to the ground states of systems of bosons or fermions for any pair interactions whatever. In particular, the N-nucleon system is considered. No ordinary central pair potential was found to give the empirical binding energies of ^2H, ^3H, and ^4He. For the exponential and square-well potentials the calculated bounds on the energies are closer than 1% over wide ranges of the potential parameters. The method justifies and generalizes certain "equivalent two-body" calculations originated by Wigner [Phys. Rev., 43: 252-7(1933)]. (auth)

15626 FISSION INTERFERENCE WITH DOPPLER BROADENING. Cook, J. L. (Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Austral. J. Phys., 20: 67-71(Feb. 1967).

The multilevel interference term between two resonances of the same spin and parity is examined and is transformed to an expression that allows the evaluation of the Doppler-broadened cross section in terms of known functions. (auth)

15627 DISPERSION RELATION FOR THE POTENTIAL IN THE OPTICAL MODEL. Passatore, G. (Univ., Genoa). Nucl. Phys., A95: 694-704(1967).

A dispersion relation derived by Feshbach for the generalized optical potential is discussed and is applied to the results of the phenomenological optical analyses. Under certain conditions, the relation may be useful for selecting among solutions of the fitting procedure and may provide a criterion to show how much the hypothesis of locality affects the energy dependence of the phenomenological potentials. (auth)

15628 ANALYTIC THEORY OF SUBCOULOMB STRIPPING. III. EXTENSION TO CASES OF ARBITRARY ANGULAR MOMENTA. Morinigo, Fernando B. (California Inst. of Tech., Pasadena). Nucl. Phys., A95: 571-6(1967).

The analytical theory of subcoulomb stripping, which was previously proposed in detail only for L = 0 stripping, is extended to cases of arbitrary orbital angular momentum and arbitrary spins of the target, projectile, exchanged cluster, and emitted cluster. An appropriate analytic parametrization of the effects of wave distortions of the optical-model type is defined in terms of radial integrals. The analytic formulas for Coulomb-wave amplitudes are rewritten in a closed form which is valid for all L, which is more convenient for numerical evaluation. Explicit expressions are deduced for stripping cross sections for cases in which the initial particles are not polarized and in which the polarizations of the products are not measured. It is conjectured that these formulas may lead to the determination of more consistent values for the reduced widths of levels produced by stripping and to good fits to the angular distributions even in the vicinity of sharp resonances. (auth)

15629 CALCULATIONS OF EXCITED NUCLEAR MOMENTS WITHIN THE FRAME OF THE IMPROVED SUPERFLUID NUCLEAR MODEL. Safarov, R. Kh. (Inst. of Nuclear Physics, Academy of Sciences, Uzbek SSR). Dokl. Akad. Nauk Uz. SSR, No. 6, 25-8(1966). (In Russian).

A superfluid model was used to calculate moments of inertia in excited rare-earth nuclei. A pair correlation method based on the approximate concept of projection operators for the functions with a definite quantum number corresponding to the conservation law was used. The method was used to calculate the moments of inertia of odd nuclei; however, the moment of inertia of even-parity system in the ground state had to be considered first. The results of the numerical calculations of the moments of inertia for even-even and odd nuclei are tabulated and are compared with data for the moments of inertia calculated by means of Bogolynbov's cononical transformation. Calculations were carried out with and without F factors. The results showed that the calculations with F factors do not alter the theoretical value (or as average $F \sim 1$). (R.V.J.)

15630 INTERACTION OF NUCLEUS WITH THE ATOMIC SHELL OBSERVED IN MOESSBAUER EFFECT. Bara, Jozef (Univ. Jagiellonskiego, Krakow). Postepy Fiz., 17: 593-608 (1966). (In Polish).

A discussion is given of the recoilless emission and absorption of gamma rays and a survey is made of interactions of the nucleus with the atomic shell observed in the Mössbauer effect. Electric monopole interaction results in a shift while the electric quadrupole and magnetic dipole interaction results in a splitting of nuclear levels. (auth)

15631 STATISTICAL THEORY OF INTERMEDIATE RESONANCES. Moldauer, P. A. (Argonne National Lab., Ill.). Phys. Rev. Lett., 18: 249-52(Feb. 13, 1967).

It is shown that in the presence of strongly absorbed channels the broader intermediate-structure resonances predicted by dynamical models of compound-nucleus formation are also predicted by statistical models of highly excited nuclear states. (D.C.W.)

15632 REFINED TREATMENT OF NUCLEAR MAGNETIC SHIELDING. Lin, Sheng Hsien (Arizona State Univ., Tempe). Mol. Phys., 12: 91-3(1967).

In measurements of nuclear magnetic resonance and nuclear magnetic moments, a correction must be made for the magnetic field arising from the motions of the molecular electrons which are induced by the externally applied field. The relativistic effects on this magnetic shielding are investigated. (auth)

15633 COMPARISON OF THE TIME-DEPENDENT AND THE STATIONARY SCATTERING THEORIES. Dolinszky, T. (Central Research Inst. for Physics, Budapest). Nucl. Phys., A95: 473-80(1967).

The introduction of the scattering matrix in different terms in the stationary and the time-dependent approaches results in unlike analytical representations. Therefore, the relation between the Rosenfeld–Humblet theory and the Schwinger–Lippmann formalism is studied. The only case in which the two approaches coincide is the elastic scattering assuming two-body forces of finite range. For many-particle processes the scattering matrices of these theories are found to differ, due to the polarizing forces arising even for finite range nucleon-nucleon interactions, by a contribution from the exterior region of the configuration space to the transition matrix. The equivalence of the different theories can be restored by a small modification of the collision matrix concept. (auth)

15634 SHELL-MODEL AND DEFORMED STATES IN OXYGEN ISOTOPES. Federman, P. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Phys., A95: 443-72(1967).

The energies and some other properties of low-lying levels in the oxygen isotopes are studied in the frame of a model including shell-model and deformed states, as well as the interplay among them. The calculations are performed using the effective interaction method, and very good agreement with experiment is ob-

tained. The results are compared with previous effective interaction calculations, and also with the predictions of phenomenological forces. Particular attention is given to the determination of the parameters and unperturbed positions of the deformed states. It is concluded that the influence of the deformed states is important in ^{18}O, but their influence in ^{19}O and ^{20}O is small. (auth)

15635 SHELL EFFECTS IN NUCLEAR MASSES AND DEFORMATION ENERGIES. Strutinskii, V. M. (Kurchatov Inst. of Atomic Energy, Moscow). Nucl. Phys., A95: 420-42(1967).

Nuclear shells correspond to an inhomogeneous distribution of nucleons in phase space, whereas the distribution in quasi-classical phenomenological models (the liquid-drop model) is supposed to be homogeneous. Starting from this point, Nilsson's level scheme is used to calculate the shell-model correction to the "liquid-drop energy" of the nucleus as a function of the occupation number and deformation. A strong correlation between the shell correction and nucleon level density at the Fermi energy was observed. In magic and mid-shell nuclei the calculated deformation energy oscillates around the LDM value. Discussion of problems related to the deformation energy such as nuclear deformations, shell effects in nuclear masses, in deformed nuclei and in nuclear fission, etc., is presented. The role of nucleon pairing is discussed. (auth)

15636 NUMBER-CONSERVING APPROACH TO THE PAIRING-FORCE MODEL. I. ALMOST-DEGENERATE MODEL. Hara, Kenji (Univ., Heidelberg). Nucl. Phys., A95: 385-419 (1967).

The pairing-force model of finite spherical nuclei is studied in a way that does not violate the conservation of particle number. The case of closely spaced single-particle levels is treated starting from a degenerate model. Numerical calculations were performed on some nickel isotopes for seniority-zero, -one, and -two states with simplified single-particle levels. The restriction imposed on the present model will be removed in a subsequent paper. (auth)

15637 THE SYMMETRY AND COULOMB TERMS IN THE PROTON OPTICAL POTENTIAL. Hodgson, P. E. (Oxford Univ.). Can. J. Phys., 45: 449-51(Feb. 1967).

It is shown that the most reliable phenomenological analyses of proton elastic scattering give a value of the symmetry term very similar to that of Perey and also establish the presence of the Coulomb term. (D.C.W.)

15638 RESIDUAL INTERACTIONS IN SPHERICAL SYMMETRIC NUCLEI. Hadermann, J.; Simonius, M. (Univ., Basel). 19p. (CONF-661039-1). DTIE.

Meeting of the Swiss Physical Society, Solothurn, Switzerland.

Introducing a residual two-body interaction in the shell model, the low-lying states are similar to collective vibrations. Energies, state vectors and transition rates were evaluated in the quasi-boson approximation which is exact for only one pair of nucleons outside the closed shell. Numerical results for some Pb and Ni isotopes are given. (auth)

REACTOR TECHNOLOGY

Central Power Reactors

Refer also to abstracts 14356 and 14357.

15639 (AD-634506) A CRITICALITY ANALYSIS OF THE ROMASHKA REACTOR. Hodgson, William Mark (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering). June 1966. 95p. (GSP/PH-66-10). CFSTI $3.00 cy, $0.75 mn.

A criticality analysis is performed on the Romashka reactor in an effort to establish the critical fuel loading and flux distribution. The analysis is in support of a complete engineering study designed to confirm or refute data on the Romashka configuration. Transport theory is used because of the small size and many interdependent regions of the system. A conservative S_n equation is derived from the Boltzmann transport equation. The equation is solved using rotational invariant quadrature for the differenced angular dependence. A code, RZSN, was written, and another code, TDSN, was used. Calculations were made using Hansen and Roach sixteen group cross sections with TDSN, and three group cross sections with RZSN. 49.00 and 71.08 kg ^{235}U loadings were found to be supercritical with TDSN. A critical mass of 55.87 kg is predicted with RZSN. Discrepancies are found between "known" fuel loading and "known" physical dimensions. The validity of the results is discussed, and directions for further investigations indicated. (auth)

15640 (APAE-112(Vol.1)) 30 MEGAWATT HEAT EXCHANGER AND STEAM GENERATOR FOR SODIUM COOLED REACTOR SYSTEM. VOLUME I. THERMAL AND MECHANICAL FINAL DESIGN. (Alco Products, Inc., Schenectady, N. Y.). Jan. 31, 1962. Contract AT(11-1)-666. 195p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The design of a 30 MW intermediate heat exchanger to transfer heat from primary reactor Na to secondary nonradioactive Na which supplies heat to a steam generator is described. The design is the shell and tube type with fixed tube sheets and sine-wave tubes. (J.R.D.)

15641 (BMI-1790) AN EVALUATION OF THE APPLICABILITY OF EXISTING DATA TO THE ANALYTICAL DESCRIPTION OF A NUCLEAR-REACTOR ACCIDENT. Quarterly Progress Report, October-December 1966. Morrison, David L.; Genco, Joseph M.; Gieseke, James A.; Ritzman, Robert L.; Walters, Craig T.; Wooton, Roger O.; Clark, William E.; Blutreich, Joachim N. (Battelle Memorial Inst., Columbus, Ohio). Jan. 1, 1967. Contract W-7405-eng-92. 57p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The study is restricted to pressurized-water and boiling-water reactors. The maximum credible accident is considered to be loss-of-coolant or blowdown situation. Calculations are reported concerning accident heat transfer using NURLOC code. The program was used to compare thermodynamic calculations of LOFT data by ANL, BMI, and Phillips Petroleum Company. Experimental measurements on UO_2 surface areas to define sphere radii for typical fuel were reviewed. Research was continued on fission product transport and deposition in reactor plenums, electric charging of aerosols, fission product transport and deposition in reactor containers, and effects of fission product removal systems. (J.R.D.)

15642 (BMI-X-10179) FISSION-PRODUCT DEPOSITION AND ITS ENHANCEMENT UNDER REACTOR ACCIDENT CONDITIONS. Quarterly Progress Report, July-September 1966. Morrison, David L.; Genco, Joseph M.; Berry, David A.; Berry, Warren E.; Rosenberg, Harvey S.; Cremeans, George E. (Battelle Memorial Inst., Columbus, Ohio). Oct. 1, 1966. Contract W-7405-eng-92. 40p. (EURAEC-1747). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States-Euratom Joint Research and Development Program.

The prefilming of Zircaloy-4 tubes in flowing primary water at 288°C was completed. After an exposure of 1000 hr, the Zircaloy-4 tubes were covered with an adherent, shiny, black oxide film (ZrO_2) which is characteristic of good-quality material. As with the stainless steel tubes, a considerable quantity of loose crud (Fe_3O_4) was found on the OD of the Zircaloy tubes, but none could be detected gravimetrically on the ID (less than 0.4 mg per dm^2). The loose crud was collected and saved for deposition on the ID of tubes for future runs where crud-coated surfaces will be studied. The results of an 8-hr preliminary run with stainless steel at 240°C in the I_2 adsorption train revealed that the background radioactivity level was sufficiently high that it was not possible to obtain an accurate count by continuous monitoring. To obtain a better indication of the actual deposition, the 18-in.-long tube sections were cut into 1-in.-long segments and each segment was counted. These results are included. Although the data obtained to date have revealed significant trends, a mathematical analysis is not justified because the end effects affected not only the deposition profile but also the analyses of the I_2 in the steam at the inlet and outlet ends of the test section. Iodine analyses at the inlet were generally lower than those at the outlet, presumably because of a somewhat larger area of bare stainless steel in the inlet connector and sampling T. On the other hand, continuous monitoring was made at the 9-in. position on the Zircaloy-4 test section in the runs at 153 and 250°C. The results indicate that the deposition rate is linear with time. A higher rate for 250°C can be attributed to higher flow rate and, consequently, a greater total quantity of I_2 at this temperature. (J.R.D.)

15643 (CONF-660221-, pp 279-82) COMPUTER CODES FOR THERMAL REACTOR PHYSICS PROBLEMS. Rastogi, B. P.; Srinivasan, K. R.; Lawande, S. V. (Atomic Energy Establishment, Trombay (India)).

Studies of the design and operational characteristics of power reactors require means to perform detailed calculations on the various physics parameters. A number of computer codes that are now available for design studies of heavy water moderated reactors are briefly described. (H.D.R.)

15644 (CONF-660221-, pp 283-6) FUEL CYCLES IN CANDU AND PHWR TYPE REACTORS. Subramanian, T. A.; Srinivasan, K. R.; Rastogi, B. P. (Atomic Energy Establishment, Trombay (India)).

The U-Pu and Th-Pu fuel cycles in the Pressurized Heavy Water Reactor and Pu recycle in CANDU are briefly described. (H.D.R.)

15645 (CONF-660221-, pp 303-6) REACTIVITY WORTH OF TRANSVERSE CONTROL RODS. Purandare, H. D. (Atomic Energy Establishment, Trombay (India)).

The method for determining the reactivity worth of control rods that are transverse to the reactor core axis is extended to the case of partially inserted rods. Results are presented for a combination of six Co control rods for the core of the Rajasthan Atomic Power Project reactor. (H.D.R.)

15646 (CONF-660221-, pp 360-5) USE OF ABSOLUTE ERROR ON DATA POINTS IN LEAST SQUARES ANALYSIS. Srinivasan, M.; Krishnamurthy, V. (Atomic Energy Establishment, Trombay (India)).

A method of least-squares analysis using the absolute experimental error on each data point is outlined. (D.C.W.)

15647 (CONF-660450-1) POWER REACTOR PROGRESS IN THE UNITED KINGDOM. Paper 12. Bainbridge, G. R. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 1966. 18p. Dep. mn.

From Advanced Gas-Cooled Reactor Symposium, Frankfurt, Germany.

Power reactors in the United Kingdom include gas-cooled reactors using magnox clad natural uranium metal fuel proven in operation with 3,400 MW(e) of an electricity generating plant, and this plant is under construction so that 5,000 MW(e) will be in operation by 1970. The nuclear power programme has been increased by 8,000 MW(e) to ensure that at least 13,000 MW(e) will be operating by 1975. It may be speculated that a target of 50,000 MW(e) could be operational by 1985 and over 100,000 MW(e) by the end of the century. The gas-cooled reactor design for the Dungeness "B" station uses a stainless steel clad slightly enriched UO_2 fuel. The station has been assessed to have generating costs 10% lower than all contemporary coal fired stations. Experience in water reactor technology is being obtained in the UK with the 100 MW(e) prototype steam generating heavy water moderated reactor at Winfrith Heath. The 250 MW(e) prototype fast breeder reactor being constructed should be available for sale when the prototype is complete in the early 1970s. Much larger stations using the same fuel and technology as the prototype should be feeding electricity into the UK grid during the last quarter of this century and for many years beyond 2000 A.D. (auth)

15648 (EUR-3171.e) COSTANZA-CYLINDRICAL, A CYLINDRICAL ONE DIMENSIONAL DYNAMICS CODE FOR LIQUID-COOLED MULTI-CHANNEL NUCLEAR REACTORS. Agazzi, A.; Forti, G.; Vincenti, E. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1966. 66p. Dep. mn.

The FORTRAN 2 version 3 Code Costanza Cylindrical is a two groups reactor dynamics code in one spatial dimension (radial). Up to 10 different composition zones and 10 cooling channels are allowed. Each channel consists of a fuel zone, gap, cladding and coolant. The thermal resistance of gap and the heat transfer coefficient at every axial level are variable functions of thermodynamic parameters. Inlet coolant temperatures and velocities may be given in input for each channel as tabulated functions of time as well as axial power distribution as function of space (kept constant during transients). Up to 10 delayed neutron groups are considered. Control rods are simulated as diluted thermal poison in each zone which may be varied in time independently according to any given law. In the initialization of each problem, criticality may be searched for by varying poison insertion in any wanted zone. Feedback reactivities in each zone are considered for both fuel and coolant average temperatures by linear coefficients for p and $\Sigma_{a\,th}$. A free test routine may be used to insert new specifications when any wanted conditions are reached during transients. (auth)

15649 (EURAEC–1653) RESEARCH PROGRAM FOR THE GARIGLIANO NUCLEAR POWER PLANT. Quarterly Report No. 8. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). Apr. 1, 1966. Contract 101-63-11-RDI. 8p. (EUR–2851). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Operating experience of the power plant is reported. Attention is directed particularly toward control systems. Information is included on operation of the data lagging computer system, performance of instrumented assemblies, studies of test procedures, and control rod oscillator studies. (J.R.D.)

15650 (EURAEC–1724) HEAT TRANSFER AND FLUID FLOW CHARACTERISTICS IN A PRESSURIZED WATER REACTOR. Quarterly Report No. 10, April 1–July 1, 1966. (Technische Hogeschool, Eindhoven (Netherlands)). Aug. 1966. Contract 011-64-1-TEEN(RD). 22p. (EUR–2896). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Experiments were carried out that were mainly connected with the instrumentation of the mixing test section. A test section was built to calibrate void-gages outside the pressure loop. Tests were also done in the pressurized loop on newly constructed void gages. Reproducibility runs were done with the air-water loop and an analysis of the results obtained with this loop was started. A theoretical study on the hydraulic coupling of parallel channels is being continued. (auth)

15651 (EURAEC–1745) THE STEADY STATE AND DYNAMIC BEHAVIOUR OF A BOILING WATER REACTOR. Quarterly Progress Report No. 22, April 1–July 1, 1966. (Technische Hogeschool, Eindhoven (Netherlands)). July 1966. Contract 030-64-1-TEEN. 22p. (EUR–3305). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

A series of experiments was carried out to investigate the influence of the heat capacity of a heating element on the characteristics in steady state as well as in non-steady state conditions. The previously used tubular element was replaced by a solid bar having the same outer dimensions but a different heat capacity. The independent variables during the experiments were power, pressure, and subcooling. The experiments did not show an effect on the steady state data nor on the threshold of instabilities. Measurements of the transfer function from power to the inlet flowrate did not indicate a significantly different stability of the system. (auth)

15652 (GAMD–7353) FLUX DISTRIBUTION MEASUREMENTS IN PEACH BOTTOM: RESULTS OF POST CONSTRUCTION R AND D TEST PROCEDURES BP-8, 10, 12. Lane, R. K.; Weiman, A. L. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Oct. 1, 1966. Contract AT(04-3)-314. 115p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Results of flux mapping experiments in the reactor are presented. The theory-experiment correlations are included, and the experimental methods and data reduction methods are described. (J.R.D.)

15653 (GAMD–7356) REACTIVITY EFFECT OF HELIUM MASS AND FLOW IN PEACH BOTTOM: RESULTS OF POST CONSTRUCTION R AND D TEST PROCEDURES BP-17 AND BP-18. Brown, J.; Van Howe, K.; Weiman, A. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Oct. 1, 1966. Contract AT(04-3)-314. 7p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The reactivity effect of adding He to the main loop was determined from changes in the critical position of a calibrated rod group with other plant variables remaining constant. The maximum He pressure was 187 psig at 70°F. The reactivity effect of He flow was also determined from the change in critical position of a calibrated rod group. Flow changes could be made rapidly enough so that temperature changes in the core during the measurement were small. These flow coefficient measurements were made at several temperatures up to 600°F. The reactivity vs. flow measurements show that the initial tilting of the reflector blocks accounts for about one half the reactivity effect of flow and the initial tilting occurs between 0 and 20% flow. The remainder of the reactivity effect is produced by continued closer packing of the reflector pieces. No significant hysteresis effects exist. (J.R.D.)

15654 (GEAP–4969) PRESTRESSED CONCRETE PRESSURE VESSELS FOR BOILING WATER REACTORS. First Quarterly Report, July–September 1965. Boggio, G. (comp.) (General Electric Co., San Jose, Calif. Advanced Products Operation). Oct. 1965. Contract AT(04-3)-189. 51p. (EURAEC–1542). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed Under United States–Euratom Joint Research and Development Program.

Ten different combinations of reactor systems and vessel shapes have been investigated in order to identify the most advantageous for the application of concrete pressure vessel technology to BWR systems. The data obtained are presented with particular regard to reactor internal arrangements, core thermal hydraulics, steam separation, coolant recirculation pumps, and refueling system. Preliminary studies on vessel thermal insulation material selection are also reported. (auth)

15655 (JAERI–1114) NUCLEAR, THERMAL-HYDRAULIC PERFORMANCE ANALYSIS OF JPDR CORE BY THE ONE-DIMENSIONAL BWR CORE PERFORMANCE ANALYSER CODE, KINAK. Kuge, Yasushi; Ishikawa, Michio; Naitoh, Yoshitaka; Itoh, Tadahiro (Japan Atomic Energy Research Inst., Tokyo). May 1966. 43p. (In Japanese). Dep. mn.

The core performance of JPDR (a natural circulation BWR) was analyzed by the one-dimensional BWR core performance analyzer code, KINAK. This code is used to compute the nuclear, thermal-hydraulic performance of a BWR core by a comprehensive scheme. The axial power distribution, the power and void coefficients of reactivity and the excess reactivity at the rated power level were calculated and compared with those measured at JPDR (or the GE design values). Results of these comparative studies are used as a basis for the conclusion that the computational model of the code and nuclear group constants used are able to represent the nuclear performance of the JPDR core within reasonable accuracy. There exists a discrepancy of about 10% between the calculated values and those measured by the instrumented fuel assembly of the recirculation flow rate and the core exit quality. The calculated recirculation flow rate is estimated to be the lower bound of the actual flow rate. Computation of the fuel center temperature and the minimum burnout ratio indicates that JPDR is operated with a wide margin with respect to the thermal design limit at its rated power. The parametric study at the rated power as well as the feasibility study at the double power with the forced circulation system are additionally performed. (auth)

15656 (KFK–465) RECHENPROGRAMME FUER DYNAMIK UND STABILITAET EINES SCHNELLEN LEISTUNGSREAKTORS. (Calculation Program for the Dynamics and Stability of a Fast Power Reactor). Frisch, W.; Schoenfeld, E. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). June 1966. 82p. (In German). Dep. mn.

In order to analyze sodium-cooled fast power reactors the present calculation programs were developed for dynamics studies and stability calculations. An analog program permits dynamic studies of the core and the primary coolant system. In this program the most important nonlinearities were considered so that the larger perturbations could be studied. For the stability investigations two FORTRAN programs were available with which various frequency pairs could be calculated which described the transition behavior of the core. Application of this digital program to other coolants as H_2O vapor is possible. (tr-auth)

15657 (KFK-466) ERGAENZENDES MATERIAL ZUM BERICHT "KERNBRENNSTOFFBEDARF UND KOSTEN VERSCHIEDENER REAKTORTYPEN IN DEUTSCHLAND" (KFK 366). (Supplementary Material to the Report "Nuclear Fuel Requirements and Costs of Various Reactor Types in Germany" (KFK 366)). Gruemm, H.; Gupta, D ; Haefele, W.; Jansen, P.; Recker, M.; Schmidt, W.; Seetzen, J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Sept. 1966. 310p. (In German). Dep. mn.

The background material used in the preparation of the report KFK-366 is presented. A detailed representation is given of the

analytical and numerical calculation methods. The projects discussed are nuclear fuel reserves and price development, nuclear energy reserves and the economy of nuclear power plants, mathematical model transformation of nuclear fuel elements in combined reactor systems, cost calculation, fuel cycle for reactors, estimation of future energy needs, and characteristic reactor data. (J.S.R.)

15658 (KFK-480) SCHNELLE BRUTREAKTOREN, IHR PRINZIP, IHRE ENTWICKLUNG UND IHRE ROLLE IN EINER KERNENERGIEWIRTSCHAFT. (Fast Breeder Reactors, Their Principles, Their Development, and Their Role in a Nuclear Economy). Haefele, Wolf (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Oct. 1966. 32p. (In German). Dep. mn.

The principles, development, and role of fast breeder reactors in a nuclear economy are outlined on the basis of a bibliographic study. The Karlsrhue fast breeder project is discussed in some detail. The studies made in Holland, Belgium, and the United States on fast breeder reactors are briefly indicated. (J.S.R.)

15659 (NP-16251(Amend.3)) BROWNS FERRY NUCLEAR POWER STATION DESIGN AND ANALYSIS REPORT, AMENDMENT 3. (Tennessee Valley Authority, Knoxville). [1966]. 211p. (DOCKET-50-259; DOCKET-50-260). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Information is included on reactor site, general design criteria, secondary containment building design, reactor vessel and internal design, instrument design, protection system design, radioactive waste system design, safety evaluation, plant and system performance, and station stability. Portions of the information are presented as answers to questions. (J.R.D.)

15660 (NP-16251(Amend.5)) BROWNS FERRY NUCLEAR POWER STATION DESIGN AND ANALYSIS REPORT, AMENDMENT 5. (Tennessee Valley Authority, Knoxville). Nov. 18, 1966. 38p. (DOCKET-50-259; DOCKET-50-260). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Errata and addenda for the Browns Ferry design and analysis report are presented. (J.R.D.)

15661 (ORNL-TM-1698) BEHAVIOR OF FISSION PRODUCTS RELEASED FROM SYNTHETIC HIGH-BURNUP UO_2 IN STEAM ATMOSPHERES (NUCLEAR SAFETY PILOT PLANT RUNS 10-12). Parsly, L. F.; Row, T. H. (Oak Ridge National Lab., Tenn.). Feb. 1967. Contract W-7405-eng-26. 79p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Data from three Nuclear Safety Pilot Plant runs are reported. In all three runs mixtures of stable and radioactive tracer isotopes of fission products simulating UO_2 irradiated to high burnups were released by melting stainless-steel-clad UO_2 to which the simulants had been added. All three runs were made with a 50-50 steam-air mixture in the containment vessel at the time the UO_2 was melted. Reducing conditions were maintained in the furnace during fuel melting in two of the runs, while oxidizing conditions were maintained in the third. Data are included on fission product release and distribution, airborne fission product concentration as a function of time, collection of condensate and of fission products in the condensate, deposition on surfaces, tests of recirculating filter systems, field tests of remote sampling devices for the Loss-of-Fluid Test, and other pertinent details of the experiments. The furnace atmosphere was found to have a major effect on the release and transport of I_2 and Ru and less significant effects on Sr, Ba, and Ce. Under reducing conditions the release of Ru and I_2 was suppressed, and very rapid deposition of the I_2 occurred in the containment vessel. No significant concentrations of Ru were found in containment vessel atmosphere samples. The amounts of fission products found in the containment vessel atmosphere samples were always less than assumed in the TID-14844 accident analysis criteria. (auth)

15662 (PRWRA-102) METALLURGICAL INVESTIGATIONS AND REPAIRS MADE ON BONUS STEAM DRYER-PREHEATER AND NONDESTRUCTIVE TESTS OF OTHER REACTOR COMPONENTS. Bonnet, Juan A. Jr.; Bonet, Carlos M.; Velez, Gilberto A. (Puerto Rico Water Resources Authority, San Juan). Oct. 31, 1966. Contract AT(40-1)-2672. 91p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Methods devised for detection and repair of failures in stainless steel dryer-preheater piping and heaters of the Puerto Rico Power Reactor are described. (P.G.C.)

15663 (RT-ING-(66)5) SISTEMA PER IL MANEGGIO, IL TRASPORTO E IL DEPOSITO DEGLI ELEMENTI DI COMBUSTIBILE IN UN REATTORE A BASSA TEMPERATURA (TIPO R.O.V.I.). (Systems for Handling, Transportation, and Decay of Fuel Elements for Organic Cooled Reactor (Type R.O.V.I.)). Cesari, F.; Vigo, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 127p. (In Italian). Dep. mn.

The mechanism described is capable of handling fuel elements of nuclear reactors cooled by liquid and, in particular, toxic coolants. This device has been fitted to the R.O.V.I. (R.O.V.I. stands for organic cooled and moderated reactor for the production of steam for industrial purposes) power reactor. All the components are supplied with doubly operated system and are moved by electric motors and manually. The same safety concept has been used for fuel element heat removal system. The system for the reactor refueling includes: a refueling machine; a decay pool; a discharge facility for the transportation of the irradiated elements to the decay pool; a well for the new fuel elements and control rods; and a skirt for removal of the pressure vessel head. (auth)

15664 (WCAP-3696-2) PRESSURIZED WATER REACTOR pH-REACTIVITY EFFECT. Quarterly Progress Report for the Period Ending December 31, 1966. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Jan. 1967. Contract AT(30-1)-3696. 51p. (EURAEC-1779). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States-Euratom Joint Research and Development Program.

An instrumented fuel assembly was designed to study crud effects on heat transfer. The assembly is being fabricated for use in Saxton Reactor to study correlation between heat transfer and conductance. Results of studies concerning local boiling and void fractions in the Saxton instrumented fuel assembly indicate that core peripheral positions will yield the required data on heat transfer, but the center core position is preferable. Results of Saxton substitution measurements indicate that there is no dependence of moderator temperature coefficient on coolant pH. The radial and axial neutron flux distributions in these tests were found to be the same at low and high pH. Data indicate that the average fuel temperature in Saxton is higher at low coolant pH. Results of measurements at the Trino Power Reactor indicate that the power defect at low coolant pH is higher than that at high pH. No variation was found in the moderator temperature coefficient of reactivity with pH change. (J.R.D.)

15665 LOCATION, STRUCTURE, AND EQUIPMENT OF REACTORS TO BE DESCRIBED IN APPLICATIONS FOR AUTHORIZATION TO ESTABLISH REACTORS. Osawa, Hiroyuki. Nippon Genshiryoku Gakkaishi, 8: 555-9(Oct. 1966). (In Japanese).

The order of the Prime Minister's Office concerning the establishment, operation etc., of reactors was revised on 23 April 1966. The revised order specifies more clearly the details of reactor facilities that must be described in applications to be presented to the Prime Minister when planning to establish reactors (location, structure, and equipment of reactor and ancillary facilities). The order stipulates that the reactor facilities, the location, structure, and equipment of the reactor described in the actual application should evidence adequate considerations and measures incorporated therein to ensure safety of the public, and further stipulates that the assurances made in the application must be strictly carried into effect during construction and operation of the reactor. Thus the details to be contained in the application assume importance. Examples of descriptions covering reactor facilities to be contained in an application, including the most important points concerning reactor safety analysis, are given. (auth)

15666 NEUTRON-FLUX AND GAMMA-RAY DOSE DISTRIBUTIONS IN THE NPR SHIELD. Greenborg, J. (Pacific Northwest Lab., Richland, Wash.). Contract AT(45-1)-1830. Nucl. Appl., 2: 430-9(Oct. 1966). (BNWL-SA-252).

Extensive neutron and gamma-ray measurements were performed in the reflector and primary shield of the NPR, a large power and plutonium production reactor. The measurements yielded fast, epithermal, and thermal-neutron flux and gamma-ray dose distributions through approximately 9 ft of reflector and shield assembly. Emphasis was placed on obtaining absolute flux and dose measurements with respect to reactor power. The measured fluxes and dose rates were compared to those calculated by the removal diffusion theory computer program MAC; a calculation in 18 removal groups and 31 diffusion groups. Agreement is excellent for fast-neutron flux and gamma-ray dose rate in the concrete shield and for thermal and epithermal flux in the graphite reflector. Calculations of thermal and epithermal fluxes in the concrete shield are in lesser agreement with measured values; generally within a factor of 2. (auth)

15667 RELEASE OF ^6Li FROM IRRADIATED BERYLLIUM-OXIDE MODERATOR MATERIAL. Stieglitz, L. J.; Zumwalt, L. R. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nucl. Appl., 2: 394-401(Oct. 1966). (GA-6743).

The release of the reactor poison ^6Li from irradiated BeO has been studied at 1000 to 1600°C. Release was found to be diffusion controlled, and diffusion coefficients were determined. The activation energy for diffusion was found to be 54 kcal/mole. It is tenta-

tively proposed that ^{6}Li diffuses in irradiated BeO by a cation vacancy mechanism. A large fractional release (99%) is estimated for the release of ^{6}Li from BeO (corresponding to the BeO granules tested) in a reactor with a moderator temperature of 1000°C. The feasibility of reprocessing "burnt-up" BeO moderator by a high-temperature treatment was investigated and found to be promising. (auth)

15668 MATHEMATICAL MODEL FOR PREDICTING COATED-PARTICLE BEHAVIOR. Prados, J. W.; Scott, J. L. (Oak Ridge National Lab., Tenn.). Nucl. Appl., 2: 402-14(Oct. 1966). (ORNL-P-1939).

A mathematical model for investigating the irradiation behavior of pyrolytic-carbon-coated fuel microspheres has been formulated. The model can be used to study the influence on coated-particle life of a number of design parameters, such as fuel particle density, number of coating layers, and coating thickness, density, and strength. For typical two-layer coated particles, the model predicts two modes of coating failure: 1) failure initiated at the inner coating surface from the combined effects of fuel swelling, fission-gas pressure, and outer coating shrinkage; and 2) failure initiated at the outer coating surface resulting from anisotropic thermal expansion and fast-neutron damage to the pyrolytic carbon structure. To assure long-term irradiation stability, a coated particle design must incorporate: 1) free volume to accommodate fission gas and fuel swelling; and 2) an outer coating material that exhibits small dimensional changes under fast-neutron irradiation. (auth)

15669 DISCHARGE VALVE FOR FLUIDIZED BED REACTOR OPERATING IN A HIGH RADIATION FIELD. Gottwald, Warren L. (Argonne National Lab., Ill.). Nucl. Appl., 2: 429 (Oct. 1966).

A process at Argonne National Laboratory involves using a fluidized bed of alumina to provide high heat-transfer rates during fluorination of irradiated uranium. A design for a valve at the bottom of the bed periodically discharging fission products is given. (J.C.W.)

15670 TIME-TO-POWER AS A REACTOR STARTUP PARAMETER. Bunch, W. L.; Philipp, L. D.; Wood, M. R. (Pacific Northwest Lab., Richland, Wash.). Nucl. Appl., 2: 357-62(Oct. 1966). (BNWL-SA-509).

A time-to-power (TTP) technique was developed and demonstrated to provide improved reactor startup instrumentation. Time-to-power is defined as the projected length of time that will elapse before goal power is reached, based on the instantaneous flux level and the reactor period. The relationships between flux, period, goal level, and TTP are presented with a discussion of possible methods of application. Design features of demonstration instrumentation are presented along with experimental results from actual startup operation. The developed technique can be utilized to achieve specific, desirable startup characteristics more efficiently than with ordinary period and level instrumentation. (auth)

15671 STUDY OF THE POSSIBILITY TO REPLACE THE PRESSURIZER IN A PWR PLANT WITH A FEED AND BLEED SYSTEM. Medeot, R.; Silvestri, M. (CESNEF, Milan). Energ. Nucl. (Milan), 13: 525-38(Oct. 1966).

A feed and bleed system to control the pressure in a PWR power plant in substitution of the pressurizer is proposed. Two different versions are investigated and the relative results, concerning the dynamic behavior of the plant controlled by the proposed system, are presented and compared to those experimentally recorded in a PWR power plant. (auth)

15672 DOUGLAS POINT: A PRECRITICAL REPORT. Can. Nucl. Technol., 5: No. 5, 19-29(Sept.-Oct. 1966).

The Douglas Point Nuclear Power Station, Canada's first commercial-scale CANDU power reactor, is in the final stages of construction and precritical testing. The history of the station is briefly examined and the various components of the reactor and electrical plants are described. (H.D.R.)

15673 CORROSION PROBLEMS IN NUCLEAR POWER STATIONS. PART II. Le Surf, J. E. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. Nucl. Technol., 5: No. 5, 41-2(Sept.-Oct. 1966).

Corrosion problems in the coolant circuits of the various types of power reactors now in use and the techniques of chemistry, development of new materials, and new methods of material treatments used to control these problems are reviewed. (H.D.R.)

15674 MAIN FUNCTIONS OF DIGITAL COMPUTERS IN THE ENEL NUCLEAR POWER PLANTS. Velona, F. (Ente Nazionale per l'Energia Elettrica, Rome). Energ. Nucl. (Milan), 14: 24-31 (Jan. 1967).

The main objectives of the installation of on-line digital computers in nuclear stations, particularly for those of the three nuclear power stations operating in Italy, are reviewed. Special reference is made to the tasks associated with the characteristics of the cores which are of three different types (gas–graphite, boiling water, and pressurized water). A mention is also made of the technical and organizational problems associated with the installation of the computers, based on the experience so far acquired in the ENEL plants. (auth)

15675 POWER ESCALATION EXPERIMENTS FOR THE E. FERMI PRESSURIZED WATER REACTOR PLANT. Campiani, A.; Giuriato, A. (Ente Nazionale per l'Energia Elettrica, Rome). Energ. Nucl. (Milan), 14: 18-23(Jan. 1967).

The most important aspects of the reactor power increase from 615 to 825 MW(t) are examined. The innovations introduced in the technical approach to this power escalation are presented and the potential saving in startup time obtainable by systematic application of these concepts is discussed. Particular attention is given to special problems encountered with the neutron flux mapping system and with the reactor nuclear instrumentation. The role played by the computer system is underlined. (auth)

15676 PHYSICS MEASUREMENTS IN OPERATING POWER REACTORS: COMMENTS ON THE RESULTS OF A SEMINAR. Farinelli, U. (CNEN, Rome). Energ. Nucl. (Milan), 14: 32-7 (Jan. 1967).

A seminar was held in Rome in May 1966, to assess the importance, potentialities, and economic implications of the reactor physics measurements that are carried out on nuclear power stations in operation. Presented are the author's personal interpretations of the present situation and prospective developments as they emerged from the seminar. (H.D.R.)

15677 EXPERIENCE IN THE CONSTRUCTION OF NUCLEAR POWER PLANTS. Leo, M. B. (Electricite de France, Paris). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 62, 15-22 (Nov.-Dec. 1966). (In French).

The connection between design, planning, and construction of a nuclear power plant is illustrated in the discussion. The characteristics of nuclear power plants studied are organization of the construction, dimensions and weights of the material, nuclear cleanliness handling devices, and the assembly frame. Specific examples are given from the Saint-Laurent Reactor. (J.S.R.)

15678 PRESTRESSED VESSELS FOR NUCLEAR REACTORS. Conversy, M. F. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 62, 23-31(Nov.-Dec. 1966). (In French).

The general plan of prestressed concrete vessels for reactors is outlined. The role of the vessel in the nuclear power plant, the form of the containers, their construction, the problems posed by various openings that must be placed in the walls of the vessel, the calculations of the vessels, and mock-up tests are considered successively. The limits of the classic technique of prestressed concrete is shown by indicating how it is possible to extend the utilization possibilities of the prestressing. (J.S.R.)

15679 FUEL HANDLING. EVOLUTION OF THE TECHNIQUE. Hainzelin, M. J. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 62, 32-7(Nov.-Dec. 1966). (In French).

The development of the fuel element grapples and their electrocarrier cables for use in the EDF-3 reactor is outlined. The conditions to which the grapple and its cable are exposed are considered. The junction between the charging weight and the discharge channel is sketched. A cross section is given of the electric grapple and its counter-weights. Possible future evolution of fuel handling techniques is briefly considered. (J.S.R.)

15680 CONTROL-COMMAND OF HIGH POWER NUCLEAR POWER PLANTS COOLED WITH CARBON DIOXIDE. Bonnemort; Escalona; Levy; Mansard. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 62, 44-62(Nov. Dec. 1966). (In French).

The actual organization of the control-command of a nuclear power plant of the type constructed in France (EDF-3 and EDF-4) was shown. Such a power plant is briefly described and the principal characteristics of the control-command are given. The roles of the numerical calculators installed in French nuclear plants are described in detail with emphasis on the solutions used in the newest installations. The problem of control rods and winches is also discussed. (J.S.R.)

15681 COST OF THE DESALINATION OF SEA WATER (ASSOCIATION OF A GRAPHITE–GAS POWER PLANT AND A MULTIFLASH DESALINATION INSTALLATION). Bidard, R.; Esclangon, P. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 62, 63-8(Nov.-Dec. 1966). (In French).

A report on desalination installations is presented. The problem of the optimization of desalination installations is considered. (J.S.R.)

15682 CRITERIA FOR CHOOSING A LOCATION FOR THE NUCLEAR POWER STATION AND RESULTS OF THE ANALYSES OBTAINED UP TO THE PRESENT. Mojovic, Ljubomir; Obradovic, Janko. Nukl. Energ., 3: No. 2-3, 59-65(1966). (In Serbo-Crotian).

Basic factors considered in selecting locations for nuclear power plants are reviewed and a survey of the proposals for the location of the first Yugoslavian plant to be in operation by 1972 is given. The criteria applied, such as the need for power in various regions and geologic, hydrologic, meteorological, and seismic characteristics of proposed locations, are presented and acceptable locations are tabulated. (H.D.R.)

15683 FEEDING PUMPS FOR NUCLEAR PLANTS: ADVANTAGES DERIVED FROM THE EXPERIENCE IN CONVENTIONAL PLANTS. Karassik, I. J.; Valentin, J. E. C.; Bush, A. R.; Paradisi, M. Termotecnica (Milan), 20: 693-701(Dec. 1966). (In Italian).

The design and development of the boiler feed pump to be used in the Nine Mile Point Nuclear Power Plant is reviewed. The concepts incorporated in its design are examined with respect to present and future needs in feed pumps for water-moderated nuclear power plants. (J.S.R.)

15684 REVIEW ON THE PRESENT DEVELOPMENT OF COMMERCIAL POWER REACTORS. Hofman, W. Atoomenergie Haar Toepass., 8: 229-37(Nov. 1966). (In Dutch).

A brief description is given of the types of nuclear reactors presently used commercially. These are the BWR, PWR, AGR, CANDU, and Magnox. The recent technical developments in the BWR and PWR with respect to the reactor system, reactor core and reactivity control, control rod drive, and containment are reported. (J.S.R.)

15685 DUNGENESS "B" A.G.R. Nucl. Energ., 248-50 (Nov.-Dec. 1966).

Dungeness "B" Advanced Gas-cooled Reactor is a 1,200 MW(e) station under construction in Great Britain and is planned to be on load in 1970. Construction, fueling, generating plants, and principal technical data are discussed. (J.C.W.)

15686 EXPERIMENTAL ASSESSMENT OF CORE PERFORMANCE UNDER NORMAL OPERATING CONDITIONS AND VERIFICATION OF SAFETY MARGINS AT INCREASED OUTPUT IN THE GARIGLIANO BWR POWER STATION. Mirone, M. (Ente Nazionale per l'Energia Elettrica, Rome); Santasilia, F.; Colling, A. Energ. Nucl. (Milan), 14: 1-9(Jan. 1967).

Equipment is described that was installed at the Garigliano power station in a program to experimentally determine and optimize the core performance under normal operating conditions and to check with special tests and instrumentation the plant safety martins, in order to evaluate the possibility of increasing the reactor output. The analysis of the data recorded during the special tests is not included. During the plant shutdown, 31 fuel elements were gamma-scanned, and the ^{140}La activity was measured through the (γ,n) reaction of deuterium. The measurement was preceded by over a month's operation with the rods kept carefully in the same position in order to have a good correlation between ^{140}La activity and power distribution. The data recorded during the gamma scanning are analyzed and compared with previously calculated data. (H.D.R.)

15687 EXPERIMENTAL DETERMINATION OF CORE REACTIVITY BUILD-UP WITH IRRADIATION IN THE LATINA NUCLEAR POWER PLANT. Bertini, A. (Ente Nazionale per l'Energia Elettrica, Rome); Lesnoni La Parola, G.; Montois, P.; Pleinevaux, C. Energ. Nucl. (Milan), 14: 10-17(Jan. 1967).

A long-range physics measurement program to be conducted at the Latina Nuclear Station is described. The program objectives are to evaluate the core reactivity changes with irradiation and to assess the validity of theoretical formulas used in core design and behavior predictions. Descriptions are presented of the factors which are included in the reactivity balance and measurement techniques by which these factors will be determined are outlined. (H.D.R.)

15688 THE DESIGN OF A PROGRAM FOR ANALOGUE ADJUSTMENT USING A DIGITAL COMPUTER AT SAINT-LAURENT-DES-EAUX. Benmergui, A. (Electricite de France, Paris). Energ. Nucl. (Paris), 8: 411-17(Sept.-Oct. 1966). (In French).

Successive adjustments in thermal power stations cannot be made, in general, while on automatic during the initial starting phases or the last phases of shutting down. Moreover, when on automatic, it is often necessary for the operator to adjust the program value of the corrected value in function of the load of the installation. The operator follows strict rules which were defined when the Power Station was first put into operation. It thus seemed logical to employ the flexibility of the digital computer to carry out startup and shutdown operations at EDF-4. (auth)

15689 LAST TEN YEARS. Gaussens, Jacques. Energ. Nucl. (Paris), 8: 390-6(Sept.-Oct. 1966).

The development of nuclear energy production and its cost include a discussion of the situation in 1955, the predictions made at this time and the conditions in which they were carried out and verified. The predictions for the long term costs of nuclear energy and the incidence of the development of nuclear power stations on the reliability of the energy supply are presented. (auth)

15690 THE INDUSTRIALIZATION OF NUCLEAR ENERGY IN THE EUROPEAN COMMUNITY. Isaac-Georges, Jacques. Energ. Nucl. (Paris), 8: 397-402(Sept.-Oct. 1966). (In French).

It is possible to predict that the production of electricity by nuclear power stations will be considerably developed in the next decade (1965–1975). During the twenty years between 1945 and 1965, the work done in this field was aimed at acquiring the necessary knowledge and experience, without attaching great importance to the immediate economic gain. It is possible to precisely define the cost of nuclear electricity production and in numerous cases this cost can be favorably compared with that of production by a classical power station and will have the effect of not only accelerating the development of nuclear power stations, but also of transforming the market conditions. It is therefore important to try to predict the rate of this development and to determine the problems that it presents to the industry of the Community. (auth)

15691 CONDITIONS AND POSSIBILITIES FOR THE DEVELOPMENT OF NUCLEAR POWER IN YUGOSLAVIA. Suica, Salom. Nukl. Energ., 3: No. 2-3, 3-8(1966). (In Serbo-Crotian).

The general aspects of the development of nuclear power plants with an independent fuel supply in Yugoslavia are discussed. The prevailing circumstances indicate that the most suitable choice of reactor would be a heavy water system using natural U fuel. The construction of a 200 to 300 MW(e) power plant and a 500 MW(e) power plant by 1980 is recommended. (H.D.R.)

15692 INCORPORATION OF NUCLEAR POWER PLANTS INTO THE ELECTROPOWER SYSTEM OF YUGOSLAVIA. Cuckovic, Dusan. Nukl. Energ., 3: No. 2-3, 9-12(1966). (In Serbo-Crotian).

The consumption of electric power in Yugoslavia is reviewed and estimates of the power demand for the 1970 to 1980 period are presented. Potential production of electricity through development of hydroelectric and fossil-fuel plants is examined and the effects of incorporation of nuclear power plants into the system are considered. The importance of coordinating development efforts on the various components of the electropower system is emphasized. (H.D.R.)

15693 TECHNICAL AND ECONOMICAL CHARACTERISTICS OF NUCLEAR POWER PLANTS AND SELECTION OF REACTOR TYPE FOR YUGOSLAVIA. Popovic, Dragoslav. Nukl. Energ., 3: No. 2-3, 18-23(1966). (In Serbo-Crotian).

Technical and economic data are compared for six types of power reactors. It is concluded that, from the technical viewpoint, nuclear power could successfully be incorporated into the electric power system of Yugoslavia. Economic criteria for the selection of the nuclear power plant type are briefly discussed. (H.D.R.)

15694 SOME ENERGETICS AND ECONOMIC ASPECTS OF NUCLEAR POWER PLANTS IN YUGOSLAVIA. Sebaher, Henrik. Nukl. Energ., 3: No. 2-3, 24-7(1966). (In Serbo-Crotian).

The economic aspects of nuclear, hydroelectric, and steam power plants in various regions of Yugoslavia are compared. Nuclear plants would be economically justified in regions of high fossil-fuel costs and in regions remote from conventional energy supplies. Hydroelectric plants in certain regions could produce cheaper electricity, but would be intended to cover only variable and peak energy demands. It is concluded that the least increase in anticipated power production expenses would be for nuclear power plants. (H.D.R.)

15695 THE NUCLEAR POWER PLANT IN THE ELECTRIC POWER SYSTEM OF THE SOCIALIST REPUBLIC OF MACEDONIA. Bogdanov, Todor. Nukl. Energ., 3: No. 2-3, 33-40(1966). (In Serbo-Crotian).

The outlook for the electric energy situation in Macedonia is discussed. If 50% of the hydroelectric potential and the total conventional energy potential are developed, there will be a serious shortage of power by 1973. The possibilities of importing electric power and of introducing nuclear plants are considered essential to supply the future energy demands of the area. (H.D.R.)

15696 INTERESTS OF THE YUGOSLAV INDUSTRIAL AND DESIGNING ORGANIZATIONS IN THE PRODUCTION OF NUCLEAR ENERGY IN YUGOSLAVIA. Gencic, Vladimir; Dokmanovic, Branko; Kulundzic, Predrag. Nukl. Energ., 3: No. 2-3, 41-4(1966). (In Serbo-Crotian).

The capacities of Yugoslav firms for the design and construction of nuclear power plants and associated facilities are surveyed. Industrial activities and expenditures in the nuclear energy field are summarized and recommendations for a national nuclear power development program are presented. (H.D.R.)

15697 RESEARCH REQUIRED FOR CONSTRUCTING A NUCLEAR POWER PLANT. Raisic, Nenad. Nukl. Energ., 3: No. 2-3, 45-9(1966). (In Serbo-Crotian).

The importance of both fundamental and applied research in nuclear power development is analyzed. In Yugoslavia, very little investment in applied research has been made. This situation indicates that nuclear energy can be incorporated into the power potential of the country in the near future only with the cooperation of a foreign partner. Recommendations for such a cooperative nuclear power development program are presented. (H.D.R.)

15698 POSSIBILITIES OF INTERNATIONAL CO-OPERATION IN CONSTRUCTION OF NUCLEAR POWER PLANTS IN YUGOSLAVIA. Afgan, Naim. Nukl. Energ., 3: No. 2-3, 54-8(1966). (In Serbo-Crotian).

The aspects of cooperation between Yugoslavia and the countries in a position to offer commercial nuclear power plants are analyzed. Major considerations discussed are the possibility of an independent fuel cycle, the possibility of future improvements in the reactor concept selected, the extent of participation of Yugoslav industries in constructing the plant, and financial arrangements. (H.D.R.)

15699 NUCLEAR POWER PROMISE: HOW THE NEW-GENERATION WATER REACTORS WILL PERFORM. Wofford, A. W. Power Eng., 70: 44-5(Nov. 1966).

Performance of nuclear power reactors is discussed in terms of availability. Availability is more important for nuclear units than for fossil-fueled units because of lower fuel cost. The data on the Yankee and Dresden plants reflect a low availability due to expected prototype testing, modifications, special physics testing, component replacements, and special refueling problems. The availability figures are low despite excellent forced outage rates. The design objective on the 550-MW(e) Millstone project is an annual availability of 98% without refueling and 92% with refueling. Refueling of a large water reactor, assuming 65% productivity factor, would require 20 days or 5.5% loss in annual availability. (TSS)

15700 XENON-INDUCED OSCILLATIONS. Canosa, Jose; Brooks, Harvey. Nucl. Sci. Eng., 26: 237-53(1966).

The Xe-induced oscillations in the power level (fundamental mode) and in the power distribution (first harmonic) have been studied for a slab reactor with prompt power reactivity feedback. One-group space-dependent kinetics equations and linearized theory are used throughout. The linear analysis rigorously predicts the onset of Xe oscillations; however, it does not say anything on how much the oscillation amplitude grows or decays. Explicit formulas giving the effects of the coupling of the infinite number of reactor modes with the fundamental mode and first harmonic are obtained and used for the first time to explain mode-coupling effects both qualitatively and quantitatively. Mode-coupling effects are quite small at the thermal flux levels of present power reactors [$10^{13} - 10^{14}$ n/(cm^{2}sec)]. At higher fluxes [10^{15} n/(cm^{2}sec)] mode coupling is destabilizing and might be significant; here the negative feedback reactivity needed to provide stability must be increased by ≈10%, relative to the value obtained from a calculation where coupling is neglected. A study has been made on the influence of the equilibrium power distribution on both types of oscillations; this study gives information concerning the effects of a reflector on reactor kinetics. A new result is that, depending on flux level, a reflected reactor may be more stable than a bare reactor against fundamental mode oscillations. (auth)

15701 NUCLEAR POWER IS COMPETITIVE. Holt, J. O. (Canadian General Electric Co. Ltd., Peterborough, Ont.). Eng. J. (Montreal), 49: 25-30(Oct. 1966).

Costs of electric power produced by several methods are compared. Conclusions drawn are that present Canadian plans for heavy water nuclear reactors promise low, stable production costs over their lifetime through the simplicity and efficiency of the natural U fuel cycle. (F.S.A.)

15702 EXPERIMENTAL BREEDER REACTOR HAS HIGH-RELIABILITY POWER SUPPLY. Verber, F.; Schmidt, H. L. (Argonne National Lab., Ill.). Power Eng., 70: 65-7(Dec. 1966).

The electric distribution system of the Experimental Breeder Reactor (EBR-II) is described. This is a Na-cooled fast reactor, coupled with a steam turbogenerator. Thermal capability of the reactor is 62.5 MW, and gross electrical capability of the plant is 20 MW. Reactor Na outlet temperature is 883°F; steam pressure and temperature at the turbine are 1250 psi and 837°F. The electrical distribution system for the EBR-II was designed for high reliability and continuity of service. Circuitry of this system is outlined. The system includes diesel motor and battery emergency sources. Under emergency conditions, the 480-V emergency switchgear bus is automatically disconnected from 480-V main switchgear; then it receives power from the 400-kW automatic-starting diesel generator unit. A single-phase, 60-cycle power supply for nuclear and process instrumentation and control is provided by a continuous power supply system. This consists of a magnetic-amplifier-type Si power rectifier, a floating 240-V storage battery, and 2 motor-alternator units. Induction and resistance heating systems are provided to maintain the Na in a molten state whenever the reactor is not in operation. (BBB)

15703 NUCLEAR POWER AND THE SAFEGUARDING OF THE PUBLIC. Bonnell, J. A. (Central Electricity Generating Board, London). Roy. Soc. Health J., 85: 347-53(Sept.-Oct. 1965).

Means whereby the general public is safeguarded from ionizing radiations or radioactive materials which arise as the result of the operation of nuclear power stations are discussed under 3 main headings: precautions taken during normal operating conditions, emergency or accident conditions involving the release of radioactive materials, and transportation of highly irradiated materials or radioactive waste products. The sources of radioactivity at nuclear power stations in Britain, including the small amounts of waste products discharged as radioactive gaseous and liquid effluents are described. Each site presents its own special problem apart from the topographical differences. A long-term ecological investigation is arranged in the form of an environmental or district survey. The remedial effects of accidental releases are discussed. A realistic and comprehensive study has been made of all potential accident conditions relative to each reactor site. The 2 major sources of highly radioactive waste products arising from the operation of a nuclear reactor are also considered. One is due to wear and tear of essential equipment from within the reactor such as control rods, which have to be replaced. The other source is the disposal of the irradiated fuel elements. Transportation of fuel elements by truck and train is discussed, along with safety features and equipment used. (BBB)

15704 REACTIVITY METER USING PASSIVE NETWORKS FOR DELAYED-NEUTRON GROUPS. Andersson, Arne J. W. (Institutt for Atomenergi, Halden, Norway). Nucl. Appl., 3: 147-56(Mar. 1967).

An instrument for measuring the net reactivity input to a reactor system has been designed and used at the Halden Boiling Water Reactor (HBWR), Norway, and at the Ågesta power reactor R3, Sweden. The design is based upon extensive use of passive networks. The instrument was carefully tested. Test results are presented as gain and phase curves for reactivity to power transfer functions and are compared with the theoretical ones. The agreement is quite satisfactory. The operational experience is good. (auth)

15705 THE SPACE DEPENDENCE OF REACTOR NOISE. II. CALCULATIONS. Sheff, James R.; Albrecht, Robert W. Nucl. Sci. Eng., 26: 207-21(1966).

The theory of space-dependent stochastic fluctuations is applied to several specific geometries to illustrate the space-dependence of the correlation and spectral-density functions. One-energy-group diffusion theory is used throughout to avoid clouding the geometric effects with other effects and to simplify the calculations. The first calculations are made in the infinite medium. The resulting cross-correlation and cross-spectral-density functions are shown to yield auto-correlation and spectral-density functions which differ strikingly from the usual point-reactor result. It is shown, however, that the point-reactor result is identical to the result obtained in an infinite reactor with a uniformly distributed detector. The effect of boundaries upon the fluctuations is examined from both the point of view of a finite detector and systems involving one or more boundaries. The case of the unreflected homogeneous cubical reactor is solved. The results of cross-correlation and spectral-density calculations are displayed. The special case of the auto-correlation and spectral-density functions is compared to the point-reactor or space-independent result to show that significant departure from space independence is to be expected if detectors are placed away from axes of symmetry. This latter result obtains even when the extraneous source distribution is assumed to be fundamental mode. (auth)

15706 REACTOR SAFETY AT POSITIVE POWER COEFFICIENTS: THE REACTIVITY OF THE KNK AS AN EXAMPLE. II. Huebel, H.; Knecht, O.; Mausbeck, H. Atomwirtschaft, 11: 566-8(Nov. 1966). (In German).

It is shown that the Na-cooled KNK reactor fulfils the safety requirements for thermal reactors at positive power coefficients. Reliability of the control, safety comparisons with other reactor types, and stability and nonlinear excursion analyses are discussed. (M.C.G.)

15707 SEMIEMPIRICAL FORMULATION OF THE DOPPLER COEFFICIENT IN FAST REACTORS. Farinelli, U.; Gandini, A.; Salvatores, M.; Sena, G. (CSN, Rome). Energ. Nucl. (Milan), 13: 409-14(Aug. 1966). (In Italian).

A parametric study was made of the Doppler coefficient in fast reactors fueled with Pu oxide. The semiempirical formulation was obtained as a function of the Na flow and core dimensions. (tr-auth)

15708 IMPROVEMENTS TO THE THEORY OF RESONANCE ESCAPE IN HETEROGENEOUS FUEL. III. SPATIAL DEPRESSION OF THE RESONANCE FLUX. Leslie, D. C.; Hill, J. G. Nucl. Sci. Eng., 26: 222-9(1966).

In resonance capture calculations, it is usual to assume that the capture in any one resonance is unaffected by the existence of other resonances: this is known as the "flux recovery" assumption. This assumption is exact for hydrogenous moderation in a homogeneous situation. However, in highly heterogeneous lattice cells such as that of the Steam Generating Heavy Water Reactor (SGHW), in which the fuel is intimately associated with a powerful moderator, the resonance flux in the fuel is depressed below that in the bulk moderator. This flux depression effect is investigated by using a model in which all moderation is hydrogenous and the resonances are square. This model suggests that the flux recovery assumption will overestimate ^{238}U capture in a typical SGHW Lattice by about 5%. (auth)

15709 SATURATION STEAM CYCLES FOR NUCLEAR POWER STATION. Stepanchuk, V. F.; Magal, B. S. (Indian Inst. of Tech., Bombay). Indian J. Technol., 4: 317-21(Nov. 1966).

The relative absolute efficiencies of different systems for the drying of, or separation of, moisture from saturated steam obtained from nuclear power reactors have been evaluated from thermodynamic considerations. The simplest system without any separation or drying cycle, single-stage, 2-stage and 3-stage separation and drying systems, with variations in the operational conditions and parameters of the systems, have been considered. The efficiency of the system using saturated steam as such is very low (0.17). The system based on single-stage drying has an efficiency of 0.29 and 0.26-0.27, with and without superheating cycle, respectively. Highest efficiency (0.306) is obtained with the 2-stage mechanical separation of moisture; the high efficiency is due to the regeneration principle employed in the system. No perceptible increase in efficiency is observed with the 3-stage drying system as compared to the 2-stage drying system. (auth)

15710 NIEDERAICHBACH NUCLEAR POWER PLANT (KKN) WITH GAS-COOLED D_2O PRESSURE TUBE REACTOR. II. ENGINEERING AND CONSTRUCTION OF INSTALLATION. Altvater, W.; Preuss, H.-J. Atomwirtschaft, 11: 562-5(Nov. 1966). (In German).

The reactor is moderated with heavy water and cooled with CO_2 and has a power of 216MW(t) and 100MW(e). The CO_2 primary circuit, the primary turbine operation, auxiliary equipment for the reactor, water supply, electrical engineering in the plant, reactor building, and safety are discussed. (M.C.G.)

15711 PHYSICAL PROBLEMS IN DEVELOPING FAST POWER REACTORS. Leipunskii, A. I.; Krasnoyarov, N. V.; Nikolaev, M. N.; Orlov, V. V.; Troyanov, M. F.; Khromov, V. V. (Physikalisch-Energetische Institut, Obninsk, USSR). Kernenergie, 9: 273-81(Sept. 1966). (In German).

Development methods for physical analysis, experiments in fast reactor physics, and determinations of nuclear data for reactor physics are the problems studied. (J.C.W.)

15712 APPROXIMATE METHOD OF ESTIMATING BURN-UP IN A PRESSURIZED-WATER REACTOR. Meyer, K. (VEB Atomkraftwerk Rheinsberg, Berlin). Kernenergie, 9: 282-5 (Sept. 1966). (In German).

A method for calculating the mean specific burn-up of the fuel in a pressurized-water reactor based on the one-group diffusion approximation is described. It is assumed that the most depleted fuel is taken off at the end of the operation period and the fresh fuel is mixed with that remaining in the core in such a manner that the mean composition of the fuel is independent of distance from core axis. (auth)

15713 METHOD OF CONTROLLING A NUCLEAR REACTOR. (to United States Atomic Energy Commission). British Patent 1,057,529. Feb. 1, 1967. Priority date Dec. 24, 1964, United States.

Design of a reactor control system is described which is effective with minimum mechanical movement. The design is useful in reactors in which elongated fuel elements are placed around a central axial fuel assembly. The upper ends of the fuel elements may be positioned to adjust their separating distances while the lower ends are held fixed. The fuel element distance adjustments control core volume and reactivity. Design drawings are included. (J.R.D.)

15714 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS. (to Babcock and Wilcox Co.). British Patent 1,057,319. Feb. 1, 1967. Priority date Dec. 13, 1962, United States.

Designs are described for incorporation into reactors to provide simpler arrangements for flattening the core axial power distribution without requiring that all fuel pins be axially zone loaded. The fuel assemblies comprise fuel bundles with elements having uniform distribution of fuel materials and those containing reduced fuel material or no fuel material. The elements with uniformly distributed fuels are in the majority and in general occupy outer positions in bundles while the elements with reduced or no fuel are centrally located. By proper fuel element positioning, the axial power distribution is flattened throughout the core. (J.R.D.)

15715 RADIATION REACTOR. (to United States Atomic Energy Commission). British Patent 1,056,305. Jan. 25, 1967. Priority date Oct. 16, 1963, United States.

Design of a reactor is described which uses radiation as the principal heat transfer mechanism between the core and heat exchanger. A high rate of heat extraction from the fuel is claimed due to the efficiency of radiation at 2000°C. Provision is made for removal of fission fragments from fuel by evaporation and diffusion to reduce the need for fuel reprocessing and to promote high fuel burnup. (J.R.D.)

15716 THREE TANK SEPARATE SUPERHEAT NUCLEAR REACTOR. (to United States Atomic Energy Commission). British Patent 1,056,607. Jan. 25, 1967. Priority date Nov. 5, 1964, United States.

Design of a reactor for superheating steam is described in which reactivity is controlled by the moderator-to-fuel ratio. Provisions for improved reactor refueling are also described along with those for use of liquid moderator and improved control rods for quick power changes. Specifications and drawings are included. (J.R.D.)

15717 REACTOR CONTROL DEVICE. Aoki, Ryozo (to Hitachi, Ltd.). Japanese Patent 1966-3597. Mar. 2, 1966. Filed Apr. 5, 1963.

The reactor control device utilizes the fact that when the neutrons penetrate through bodies of Fe, Co, etc. highly magnetized in certain directions, the penetration and reflection of the neutrons differ, depending upon the direction of spin deflection of the neutrons. Within or surrounding the reactor core two layers of highly magnetized bodies are installed. The neutron density in the core can be controlled by changing electrically the magnetic intensities and/or magnetizing directions of the two layers. (NSA of Japan)

15718 METHOD OF OPERATING A NUCLEAR REACTOR WITH TWO CORE SECTIONS. Azuma, Masao (to Hitachi, Ltd.). Japanese Patent 1966-3595. Mar. 2, 1966. Filed Jan. 16, 1963.

A method to operate a reactor divided in two core sections and control both the operation and reactivity by changing the condition of the two sections is presented. Two advantages are obtainable by this method: one is the prevention of the decrease in the burn-up due to the accumulating fission products, and the other is the elimination of an out-of-pile cooling pond (usually used to enable the re-burning of a once-burnt fuel) by means of the in-pile decay of the fission products. The reactor core has two sections; one section alone cannot cause the reactor to become critical. Part of the central core section, which has been partially burned, is removed from the criticality region in the next stage to make room for the following part to burn. This movement of the central core section, relative to the outer core section, is repeated for the advantageous operation of the reactor. (NSA of Japan)

15719 COMBINED-REGION TYPE SUPER-HEATING REACTOR. Azuma, Masao (to Hitachi, Ltd.). Japanese Patent 1966-3599. Mar. 2, 1966. Filed Mar. 22, 1963.

In the combined-region type super-heating reactor, which consists of the steam super-heating, fast neutron region and

the coolant-boiling, thermal neutron region, an improvement is made by connecting the two regions. Between the outer thermal and the central fast region is located a vertical annular space, and in this space a rotary cylindrical body made of a good neutron-reflection material is inserted. By rotating this reflector body, part of the neutrons taking part in the connecting of the two regions can be stopped or moderated, thereby changing the spectrum and density of the neutrons passing through the annular space. This makes it possible to change the state of combination of the two regions. (NSA of Japan)

15720 MIXED-SPECTRA, COOLANT-FLOWING, SUPERHEATED-STEAM NUCLEAR REACTOR. Morita, Takahiro (to Hitachi Ltd.). Japanese Patent 1965-27274. Nov. 30, 1965. Filed Dec. 28, 1962.

An improved superheated-steam reactor, in which the steam is produced by fission heat, is proposed. This type of reactor is usually of mixed spectra. That is, a plurality of operating regions are employed, namely the two regions where the coolant water is boiled and the produced steam is super-heated, respectively. In the mixed-spectra, superheated-steam reactor proposed, the reactor core is uniquely constructed, so as to give both thermally and in nuclear characteristics an efficient reactor. The core of the reactor proposed is made up of three different regions. In the outermost region, which has a thermal neutron spectrum, the coolant water is boiled. The next (radially inwards) region, which is of an intermediate neutron energy spectrum, is in a so-called transition region for the following steam-superheating. In the final region in the middle of the core, which is of a fast neutron spectrum, the steam produced is superheated. The coolant flows through the three regions appropriately. (NSA of Japan)

15721 THE PLACE OF THE FAST REACTOR IN THE U. K. NUCLEAR PROGRAM. Searby, P. J. (United Kingdom Atomic Energy Authority, London); Iliffe, C. E. 20p. (CONF-660502-3). ORAU.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London.

An assessment of fast reactor development and use in the U. K. is presented. Discussions are included concerning electricity demand growth, nuclear power as the cheapest source of electricity, fast reactor relations with the U. K. power programs, and economics of Na-cooled fast breeders. It is concluded that if fast reactors achieve the performance that is now being promised from them, their place in the program is assured. (J.R.D.)

15722 NUCLEAR REACTOR PLANT AVAILABILITY. Bierman, George F. (Metropolitan Edison Co., Reading, Pa.); Miller, Walter J. 40p. (CONF-660606-21). ORAU. Gmelin, AED-CONF-66-203-8.

From American Nuclear Society Meeting, Denver.

Nuclear central station plants in the United States have accumulated a significant number of kWh generation time. Plant availability has been affected most by refueling operations, maintenance and testing. As refueling procedures and operating and maintenance procedures were improved and as design problems were remedied, the number and duration of plant outages decreased. Operating experience with this generation of nuclear plants indicates that the availability of nuclear plants compare favorably with fossil units of the same size. (auth)

15723 ONE-GROUP THREE-DIMENSIONAL ANALYSIS OF ASSEMBLYWISE POWER AND EXPOSURE DISTRIBUTIONS IN YANKEE CORE I. Rosztoczy, Z. R.; Valerino, M. F. (Combustion Engineering, Inc., Windsor, Conn.). 5p. (CONF-660606-31). ORAU. Gmelin, AED-CONF-66-203-32.

From American Nuclear Society Meeting, Denver, Colo.

A one-group three-dimensional analysis of assemblywise power and exposure distributions in Core I of the Yankee Reactor was compared to both measured distributions and the results of more sophisticated two-dimensional burnup calculations. The accuracies of the results are comparable to both the measured and more sophisticated calculations, and computing time requirements are greatly reduced. (J.C.W.)

15724 METHOD FOR FLATTENING THE POWER-OUTPUT DISTRIBUTION IN A NUCLEAR REACTOR. Umeda, Iwao (to Japan Steel and Tube Corp.). Japanese Patent 1966-2280. Feb. 15, 1966. Filed July 26, 1962.

By utilizing distribution-flattening rods, which are of different materials and whose positions in a nuclear reactor can be changed, the neutron-flux, and hence power-output distribution in a boiling water-type reactor can be favorably flattened. This results in an increase of the power production, an increase in the fuel burnup, and prevention of damage of reactor fuel. (NSA of Japan)

15725 NUCLEAR POWER ECONOMICS. AN APPRAISAL OF THE CURRENT TECHNICAL-ECONOMIC POSITION OF NUCLEAR AND CONVENTIONAL GENERATION. Sporn, Philip. New York, American Electric Power Co., Inc., [1966]. 30p.

The growth of the nuclear power industry during late 1964 and the year 1965 is reviewed and the economics and technology of fossil-fuel-fired and nuclear electric generation are analyzed. (H.D.R.)

15726 NUCLEAR SAFETY. Volume 8, Number 2. Cottrell, Wm. B.; Jordan, W. H.; Blakely, J. P. (eds.). Contract W-7405-eng-26. One of the five Quarterly Technical Progress Reviews published for the Division of Technical Information, USAEC. Oak Ridge National Lab., Tenn., Winter 1966-1967. 120p. GPO $1.00 Domestic, $1.20 Foreign.

Separate abstracts have been prepared for 15 sections presented on nuclear safety. (F.S.)

For abstracts of individual papers see: 14333, 14408–14410, 14912, 15727–15732, 15748, 15771, 15772, and 15821.

15727 A REVIEW OF THE GENERALIZED REACTIVITY ACCIDENT FOR WATER-COOLED AND -MODERATED UO_2-FUELED POWER REACTORS. Bright, Glenn O. Nucl. Safety, 8: 116-27(Winter 1966-1967).

A review was made of what is known and, conversely, what is unknown about the factors that enter into the determination of the course and consequences of reactivity accidents, and a collection of information on the various phases of reactivity-accident analysis to identify the major problem areas is reported. The review of existing knowledge of both neutronic and nonneutronic phenomena, as well as the consideration of the limits of confidence in analytical methods and the accuracy of values for fundamental parameters used in the analyses, made it increasingly evident that a really quantitative analysis of a large reactivity accident in a power-reactor system is not possible at this time. (auth)

15728 COMPUTER CONTROL FOR REACTORS. Bullock, J. B. Nucl. Safety, 8: 138-9(Winter 1966-1967).

Papers presented at the symposium on the Use of Computers in Analysis of Experimental Data and the Control of Nuclear Facilities indicate that digital computers are being used for reactor control. The application of digital computers to reactor safety systems is still a subject of debate. The use of a single computer to perform both primary safety- and control-safety functions is not recommended in the light of current safeguard-design philosophy. (auth)

15729 EMERGENCY HEAT REMOVAL AND RELIABILITY OF AUXILIARY POWER SYSTEMS IN BOILING-WATER REACTORS. Rubel, P. Nucl. Safety, 8: 139-47(Winter 1966-1967).

Practical reliability aspects of emergency heat-removal systems in five boiling-water reactor power plants are reviewed. Reliability criteria for the support emergency power supplies are developed informally through consideration of vital-function performance requirements under accident conditions postulated in safeguards reports. Counterpart features are compared among the plants. The demands imposed on the power supplies were found not to have changed fundamentally during recent years, although new emergency heat-removal systems have been added. There has been increased emphasis on prompt operation of some emergency systems accompanying the higher reactor power ratings and core power densities. (auth)

15730 STATUS OF PIPE-RUPTURE STUDY AT GENERAL ELECTRIC. Vandenberg, Stuart R. Nucl. Safety, 8: 148-55 (Winter 1966-1967).

Results of pipe-rupture studies concerned with improving understanding of failure-causing mechanisms and providing improved capability for evaluating and monitoring reactor piping systems to minimize the probability of failures are presented. A review to determine the work most needed to improve nuclear system piping was conducted and analytical and experimental efforts were started. The accomplishments during the initial year of a broad 4-year program in reliability engineering of reactor piping systems, solution of heretofore intractable problems in stress analysis, application of fracture mechanics to ductile materials, and fatigue studies through both bench-scale and large-component tests are summarized. (auth)

15731 PROGRESS SUMMARY OF NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROJECTS. Whetsel, H. B. Nucl. Safety, 8: 182-99(Winter 1966-1967).

Information on light water reactor safety is summarized for reactor kinetics and related studies, primary system integrity, accident analysis, fission product behavior, and the safety-test experiment program (LOFT). Information on Na-cooled fast reactor safety is summarized for reactor kinetics and related studies, and fission-product behavior. Information on gas-cooled-reactor safety is summarized for reactor kinetics and

related studies. Other information is included on transportation and storage of radioactive material, radionuclide release and environmental movement, operational safety, and general safety studies. (J.R.D.)

15732 ACTION ON REACTOR PROJECTS UNDERGOING REGULATORY REVIEW. Blakely, J. P. Nucl. Safety, 8: 202-10(Winter 1966-1967).

The license-application records of various power reactors are tabulated. Experimental reactors are also listed in the tables and discussed. Recent regulatory actions relating to various reactors are summarized. Information is also included on difficulties or unusual occurrences that were reported. (J.R.D.)

15733 HIGH TEMPERATURE REACTORS AND THE DRAGON PROJECT. A Two-Day Symposium Held at the Institution of Civil Engineers on 23-24 May 1966. J. Brit. Nucl. Energy Soc., 5: 222-469(July 1966). (CONF-660554).

Seventeen papers are included. Separate abstracts were prepared for each paper. (J.R.D.)

For abstracts of individual papers see: 14913, 15734—15747, 15793, and 15794.

15734 HIGH TEMPERATURE REACTORS AND THE DRAGON REACTOR EXPERIMENT. Shepherd, L. R. (United Kingdom Atomic Energy Authority, Winfrith, Eng.). J. Brit. Nucl. Energy Soc., 5: 237-43(July 1966).

Current developments of the HTGCR center mainly around He-cooled, graphite-moderated thermal-neutron systems using Th fuel cycles. The reactor physics of the HTGCR was investigated and the results demonstrate favorable fuel cycle characteristics, particularly with Th as the fertile medium. The behavior of graphites under fast neutron irradiation at high temperature was studied and the problems arising from this in the design of HTR cores are now well understood. The problems of continuous purification of He coolant and the maintenance of adequate degrees of purity to prevent excessive C transport were investigated. Satisfactory solutions to these problems in large power reactors do not appear to be difficult to achieve. The 20 MW-reactor experiment constructed by the Dragon Project and now in operation provides a powerful tool in the investigation of the problems of high-temperature gas-cooled reactors and, particularly, in the further development of core materials. (J.R.D.)

15735 DESIGN FEATURES OF THE DRAGAN REACTOR EXPERIMENT. Franco, G. (United Kingdom Atomic Energy Authority, Winfrith, Eng.); Midtboe, T.; Shilling, W. F. J. Brit. Nucl. Energy Soc., 5: 244-56(July 1966).

A survey of the main problems arising in the design of the Reactor is presented. The basic requirements of design, and the system evolved in the Project to ensure uniformity of design philosophy of all the various components by preparation of detailed specifications, is described. Many of the contracts were let on a design and manufacture basis and the role of the Project in this type of contract is defined. Outline details and the basis of design for the primary circuit, the importance of leak tightness, and instrumentation and electrical requirements and their safety features are discussed. A brief description of the history and the final design of the heat removal circuit is given with emphasis on the various fault conditions. The advantages of totally enclosed circulator units are discussed together with a summary of the development problems arising with this novel type of component. The design of the whole reactor complex is reviewed and the lessons to be drawn from this review are discussed. (auth)

15736 HELIUM COOLING OF HIGH TEMPERATURE REACTORS. Hosegood, S. B.; Roemberg, E.; Coast, G. (United Kingdom Atomic Energy Authority, Winfrith, Eng.). J. Brit. Nucl. Energy Soc., 5: 257-72(July 1966).

The requirements of the coolant gas for high temperature reactors are examined. A brief survey of the possible gases shows He is the most appropriate for this purpose. The problems of He purification are discussed and the purification plant now operating successfully in the Dragon Reactor Experiment is described. The purification requirements for a large power reactor are different, and the methods proposed for meeting these are indicated. Project experience with bearings, seals, circulators, and compressors for pure He is discussed. The conclusion is reached that the necessary technological basis was established to make He a proved and practical coolant for high temperature reactors. (auth)

15737 CONSTRUCTION, TESTING, AND COMMISSIONING OF THE DRAGON REACTOR EXPERIMENT. Midtboe, T.; Shilling, W. F. (United Kingdom Atomic Energy Authority, Winfrith, Eng.). J. Brit. Nucl. Energy Soc., 5: 273-80(July 1966).

The organizational requirements of an international Project to ensure manufacture in accordance with the standards laid down in the contractual specifications for plant items are discussed. The features of the Reactor requiring particular attention and special testing are mentioned, and the implications of high leak tightness standards at manufacture are discussed. Details of manufacturing and testing problems at works are given. The construction at site is described, where this is peculiar to high temperature reactor systems, and it is shown how the component commissioning program was arranged to enable construction to proceed with the minimum of delay. The organization required to carry out site construction, testing, and commissioning is discussed. The importance of adequate documentation is emphasized and methods of presentation used are described. The results of commissioning tests are given and discussed where they vary from predicted values. A review of the commissioning program is included to show where faults have occurred owing to failure in design or organization, and recommended improvements are suggested. (auth)

15738 REACTOR PHYSICS OF THE DRAGON REACTOR EXPERIMENT. Hintermann, K. O.; Schroeder, E.; Gutmann, H. (United Kingdom Atomic Energy Authority, Winfrith, Eng.). J. Brit. Nucl. Energy Soc., 5: 281-90(July 1966).

A description of the Dragon Reactor Experiment and the philosophy behind its physical layout with special regard to the testing of HTR fuel elements is presented. A survey of the reactivity calculations for the first approach to criticality and the loading to the fully loaded stage together with the results of the experiments are included. Both the theoretical and the experimental methods are outlined. Theoretical results of the temperature coefficients and the ^{235}U fission rate distribution are reported and compared with results of measurements which took place during the zero energy phase of reactor operation. A special point refers to the first results from a transfer function analyzer and its usefulness as a tool of calibrating control rods at all power levels. The comparisons show good agreement between experiment and theory and prove the reliability of the applied methods. (auth)

15739 INITIAL OPERATING EXPERIENCE WITH THE DRAGON REACTOR EXPERIMENT. Barclay, F. J.; Chapman, B. G. (United Kingdom Atomic Energy Authority, Winfrith, Eng.). J. Brit. Nucl. Energy Soc., 5: 291-304(July 1966).

A review is given of Dragon Reactor problems accompanied by notes on their resolution resulting in the rapid commissioning and initial operation of this experiment. Unexpected problems solved during the approach to power are also explained. The factors which were taken into account in drawing up the plan for approach to power are stated and attention is drawn to the hot over pressure test of the steel reactor vessel. This test provided the justification for discounting a major vessel failure in the safety analysis of the approach to power. A chronological account of operating experience during the approach to power and subsequent period of steady operation, and final conclusions of particular interest to reactor operators are included. (auth)

15740 DEVELOPMENT OF THE HIGH TEMPERATURE GAS COOLED REACTOR AND THE PEACH BOTTOM HIGH TEMPERATURE GAS COOLED REACTOR PROTOTYPE. Duffield, R. B. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). J. Brit. Nucl. Energy Soc., 5: 305-18(July 1966).

Operations to date at the Peach Bottom station have included loading the reactor and measurements many of its characteristics in a low-power testing program. The experimental program has gone well and has shown that the nuclear and reactor physics design objectives were attained. Major plant components were operated in the course of a demonstration program. It is anticipated that the plant will be taken to design power during the coming months. (auth)

15741 AVR PEBBLE BED REACTOR. Mueller, H. W.; von der Decken, C. B.; Hennings, U.; Stuermer, W. (Brown Boveri/Krupp Reaktorbau, GmbH, Mannheim, Ger.). J. Brit. Nucl. Energy Soc., 5: 319-31(July 1966).

The pebble bed reactor core consists of a pile of spheres loosely bedded in a cylindrical graphite cavity. By gravity a reactor is obtained with mobile fuel, that allows refueling under load. Integrated design is one of the special features of the AVR plant. The elevated operating temperatures of core and coolant permit the use of a modern conventional steam turbine cycle. The cylindrical core contains initially approximately 100,000 fuel and moderator spheres. Two oil lubricated blowers circulate He in upward flow through bottom reflector, pebble bed and top reflector to the generator. Supply of fresh spheres, extraction of elements with high burnup rates, and ball circulation are carried out by a special fueling system. No excess reactivity has to be built in. Only safety rods are provided for start-up and shut-down purposes. Theoretical and experimental investigations

demonstrate the good performance of the pebble bed concept, in particular with respect to flow and heat transfer conditions. These properties allow favorable temperature distributions in the core and coolant. A computer issues the fueling program. A fifa value of 0.8 is expected with the first fuel charge. (auth)

15742 PROJECT FOR A HIGH TEMPERATURE REACTOR WITH A GAS TURBINE. Boehm, E. J. Brit. Nucl. Energy Soc., 5: 332-44(July 1966).

Characteristic features of the high temperature reactor are high power densities and coolant temperatures above 700°C which allow the adoption of a compact reactor design with low specific investment cost. The coolant temperatures permit the use of modern steam turbines and the combination of the reactor and a gas turbine in a closed circuit. By combining a high temperature reactor and a gas turbine, the advantage of high temperature operation can be exploited fully. In the past few years GHH has been engaged in several studies on the combination of gas-cooled high-temperature reactors and gas turbines. The main object of these studies was to develop heat and power plants of this type and ship propulsion units. At present GHH is carrying out project work for a 20 MW(e) closed cycle gas turbine prototype plant utilizing a He-cooled high-temperature reactor with prismatic fuel elements. Construction work could be started in the spring of 1967 so that the plant could be put into operation at the end of 1970. The prototype plant is discussed and those aspects which arise from combining a gas turbine and a high-temperature reactor are considered. (auth)

15743 THORIUM HIGH TEMPERATURE REACTOR PROJECT. Jelinek-Fink, P. (Kernforschungsanlage, Juelich, Ger.); Rausch, W.; Schafstall, H. G.; Schulten, R.; Valette, L. J. Brit. Nucl. Energy Soc., 5: 383-95(July 1966).

An account is given of the work performed by association for Th high-temperature reactor serving the general purpose of the advancement of high-temperature pebble bed reactors utilizing the Th–U cycle and the design of a prototype reactor representative of a full scale power plant. The main characteristics of the prototype reactor are presented. Information on special details such as fuel elements, core design, fuel element cycle, cooling circuits, and safety aspects are given. Specific results of the research and development work are reported. (auth)

15744 DESIGN CONCEPTS FOR POWER REACTORS. Lockett, G. E.; Hosegood, S. B. (United Kingdom Atomic Energy Authority, Winfrith, Eng.). J. Brit. Nucl. Energy Soc., 5: 396-407(July 1966).

The development possibilities of high temperature gas cooled reactors lead to studies of various potentially attractive schemes which utilize a cheap and flexible fuel cycle in a compact low cost reactor. Core temperatures are not critically important and can be raised to values which more than satisfy the cycle requirements of practical high efficiency power conversion schemes. Designs were evolved and some examples are presented. Reactor power plants of immediate interest are those which utilize steam cycles suitable for the present, basically standard, large turbo-alternator sets. The possibility of using the closed-cycle gas turbine is included. (auth)

15745 POWER REACTOR CORE STUDIES. Marien, P. (United Kingdom Atomic Energy Authority, Winfrith, Eng.). J. Brit. Nucl. Energy Soc., 5: 429-41(July 1966).

General thermal design formulas — and related computer programs — which can be used to optimize the core design of various reactors, using different fuels and coolants are presented. These formulas are applied to the study of high-temperature gas-cooled power reactors and the feasibility is demonstrated to design such reactors with acceptable core temperatures, for different fuel cycles and fuel management schemes, under the operating conditions selected for the Dragon power reactor assessment studies. The incorporation of the thermally optimized fuel cell geometries in fuel elements, with due consideration of corrosion, fission product migration, core stability, fuel handling, and manufacturing problems is discussed. (auth)

15746 AN ASSESSMENT OF HIGH TEMPERATURE POWER REACTORS. Rennie, C. A. (United Kingdom Atomic Energy Authority, Winfrith, Eng.). J. Brit. Nucl. Energy Soc., 5: 442-54(July 1966).

The status of the high temperature reactor is reviewed considering development costs, engineering design, fuel technology, full cycle costs, capital costs, and generating costs. The present position seems very favorable but it is clear that no reactor system can survive in the long term unless it is truly competitive both now and in the future. The utilization of natural U resources, the effect of increases in the price of U, the resources available, and the nuclear power potential and requirements are examined. The arguments put forward show that the high temperature reactor is well suited to meet future requirements. U enrichment capacity and He supplies are discussed along with the place of high-temperature reactors in nuclear power programs. High-temperature reactors should play an important role in the future of nuclear power. (auth)

15747 CALCULATION OF THE CARBON ATOM DISPLACEMENT RATE IN THE BEPO CORE AND REFLECTOR. Wright, S. B. (Atomic Energy Research Establishment, Harwell, Eng.). J. Brit. Nucl. Energy Soc., 5: 455-61(July 1966). (AERE-M-1548).

The Thompson and Wright model for atomic displacements in graphite is used, together with a Monte Carlo calculation of the neutron spectra, to predict the displacement rate as a function of distance from a single infinitely long BEPO fuel channel. This function is used to calculate the distribution of damage in the region of the BEPO core/reflector interface, and these results are compared with the experimental results obtained by Kinchin in 1951. It is suggested that this method of calculation gives a more satisfactory means of predicting damage rates in graphite reactors than the calculations based directly on Kinchin's absorption curve of damage in graphite. (auth)

Marine and Portable Power Reactors

15748 THE ROLE OF THE U. S. COAST GUARD IN NUCLEAR MERCHANT SHIP SAFETY. Bosnak, Robert J. Nucl. Safety, 8: 102-15(Winter 1966-1967).

A description of the role of the U. S. Coast Guard in nuclear merchant ship safety is presented. Nuclear ships are subject to the same laws and regulations for construction of the hull and the machinery and for operations and manning as conventionally powered ships. The provisions of SOLAS '60 and the Coast Guard regulations and tentative requirements covering design, certification, and periodic testing are noted. Included are design requirements for nuclear pressure vessels, containment vessels, primary- and secondary-system safety valves, piping systems, shipboard accelerations, hull strength and collision protection, fire protection, emergency propulsion, and electrical engineering. (auth)

15749 EMERGENCY POWER PLANT DESIGNED AFTER THE LOFFLER PRINCIPLE FOR SHIPS WITH NUCLEAR POWER PLANTS. Moeck, E. (Rostock Univ., Ger.). Schiffbautechnik, No. 8, 397-9(1961). (In German).

An emergency power plant for nuclear powered ships is proposed. The design is based on the "Loffler principle" in which the greatest part of the live steam generated is used to vaporize the condensate used in the power plant and to effect the removal of heat from the boiler only through the superheating of the saturated steam generated in this vaporizer. In the design of the power plant the same safety features can be incorporated at a lower cost, or more safety features can be incorporated for the same cost required in the case of a nuclear power plant. The proposed power plant could be used with a separate superheater independently of whether it is fired separately or is designed as a steam-cooled reactor. It is proposed that using the superheater in two functions represent a new design and might be of importance for sea going passenger ships. (ATD)

15750 LOW-CAPACITY NUCLEAR POWER MARINE PROPULSION PLANT. Buchholz, Eberhard; Moeck, Eckard; Schmuck, Peter. Wiss. Z. Univ. Rostock, Math.-Naturwiss. Reihe, No. 2, 219-35(1963). (In German).

Methods and results of an investigation of various power plants for ships are discussed. Particular attention is given to the thermodynamics of plants with steam-cooled and gas-cooled reactors, and to the design of the aggregates and the engine room required in a plant with a steam-cooled reactor. A comparison is made of investigations using pressurized water reactors and boiling water reactors. (ATD)

15751 NUCLEAR POWER PLANTS AND MAINTAINABILITY. McGinty, F. C. (Martin Co., Baltimore). Human Factors, 7: 355-61(Aug. 1965).

The effect of radiations on maintenance of nuclear power plants is considered, with examples of how an acceptable degree of maintainability is achieved on a specific military nuclear power plant. Developmental programs that will significantly improve the maintainability of nuclear power plants are also described. From the maintainability point of view, radiations affect materials in 2 ways: by inducing radioactivity in various components of the reactor system, outside the reactor core, and by alterating the physical properties of components. Coping with safety problems in the MH-1A Nuclear Power Plant, now under construction, is considered in detail. Shielding and refueling equipment and procedures of this system are revealed. Future developments discussed in-

clude reactors having 5- to 10-yr lives, thus eliminating refueling during the useful life of military equipment, as well as automatic reactor control techniques that will eliminate the need for an operator except for startup and shutdown operations. (BBB)

Rocket and Space Reactors

Refer also to abstract 14362.

15752 (LA-DC-8482) A STUDY OF A NUCLEAR THERMIONIC PROPULSION SYSTEM. Salmi, E. W. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 4p. (CONF-670111-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From American Institute of Aeronautics and Astronautics Meeting, New York.

A study was made of a nuclear electric space propulsion system. This study assumed that the system was composed of a thermionic reactor, "heat pipe" radiator and a Li arc jet propulsion unit. The specific weight of the entire system (unshielded) was 3.9 kg/kW jet power. Because of limited experimental evidence on fuel burn-up, the reactor operating time may be limited to 5000 hrs. This operating time is sufficient to accomplish the manned Mars mission. (auth)

15753 (N-66-23593) RESEARCH IN AND THE APPLICATION OF MODERN AUTOMATIC CONTROL THEORY TO NUCLEAR ROCKET DYNAMICS AND CONTROL. VOL. II. Semiannual Status Report. Higgins, Walter T. Jr.; Schultz, Donald G. (Arizona Univ., Tucson, Dept. of Nuclear Engineering). Mar. 1966. 152p. (NASA-CR-74134). CFSTI $3.00 cy, $0.65 mn.

The Second Method of Liapunov, the Popov frequency criterion, and the matrix inequality method were used to study the stability of certain nonlinear and/or time dependent control systems. The types of systems considered are described and stability definitions and theorems of the Second Method are given. The Liapunov function used is of the Lurie type, i.e., a quadratic for the state variables plus the integral involving the nonlinearity. The use of a quadratic Liapunov function without the integral for a system with a single time dependent element is shown and it is pointed out that the inclusion of the integral results in a Liapunov function which is no longer V(x), but is V(x,t). The matrix inequality method was extended for systems with more than one nonlinearity or time dependent element. This allows stability criteria, which are analogous to criteria for single element systems, to be derived for poly element systems. (STAR)

15754 (N-66-37315) A FUNDAMENTAL AND FEASIBILITY STUDY OF RING-VORTEX GASEOUS-CORE CAVITY REACTOR. Semiannual Report No. 5, February 1-July 31, 1966. Chang, C. C. (Catholic Univ. of America, Washington, D. C.). Aug. 1, 1966. 19p. (NASA-CR-78048). CFSTI $3.00 cy, $0.65 mn.

The progress made in understanding the flow pattern in three types of reactor models is summarized. The models studied were the cylindrical geometry, toroidal geometry, and a two dimensional improvement on the Lewis Coaxial Core Reactor. It was found that the square step end walls of equal diameters are definitely promising in reducing secondary flow loss in the cylindrical model. The great advantage of toroidal geometry is the fluid vortex ring which has no open ends; therefore, the secondary flow loss can be eliminated. It is stated that further study is required on the two dimensional model. Abstracts of papers on radiative transfer for parallel streams of radiating gases, mass transfer between two parallel streams, and the stability of Helmholtz flow are also included. (STAR)

15755 (N-66-37406) REVIEW OF INDUSTRY-PROPOSED IN-PILE THERMIONIC SPACE REACTORS. VOLUME I, GENERAL. Davis, J. P.; Gronroos, H.; Phillips, W. (Jet Propulsion Lab., Pasadena, Calif.). Oct. 15, 1965. Contract NAS7-100. 19p. (NASA-CR-78331; JPL-TM-33-262(Vol.1)). CFSTI $3.00 cy, $0.65 mn.

The present status of development and the problem areas associated with design are summarized. For a given fuel and at low power levels — less than 200 kW(e) — the externally fueled concept, by virtue of its high attainable fuel-volume fraction, results in smaller cores than the flashlight or single-diode internally fueled concepts. At higher power levels the differences are less pronounced. None of the potential nuclear fuels for thermionic reactors have yet demonstrated the burnup capability required for high-power, long-life systems. (STAR)

15756 (N-66-38502) EXPERIMENTAL INVESTIGATION OF A CONFINED, JET-DRIVEN WATER VORTEX. Roschke, E. J. (Jet Propulsion Lab., Pasadena, Calif.). Oct. 1, 1966. Contract NAS7-100. 50p. (NASA-CR-78550; JPL-TR-32-982). CFSTI $3.00 cy, $0.65 mn.

The effects on a confined vortex flow produced by varying the aspect ratio in a gaseous-core reactor were studied. Radial distributions of static pressure, measured at the closed end-wall of a nominal 4 inch, confined, jet driven water vortex, are presented for an aspect ratio range of $0 < L/D < 12$. Tangential velocity distributions are also presented to give some indication of the effects of exit-hole size and aspect ratio. The data show that an increasing aspect ratio (L/D) produces a corresponding reduction in the size of the vortex core. This indicates that increases in aspect ratio to larger values would have the adverse effect of producing vortexes of decreasing strength, if the pressure at the cylindrical wall were held fixed. The possibility of restrictions, imposed by this factor, on the performance of multiple vortex-tube gas core reactors is assessed. (STAR)

15757 (TID-23651) PERFORMANCE CHARACTERISTICS OF ETS-1 NUCLEAR EXHAUST SYSTEM, NERVA PROGRAM. (Aerojet-General Corp., Azusa, Calif.). June 1964. Contract SNP-1. 53p. (RN-S-0099). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Test results of the ejector scale model test program as they apply to the full scale Engine Test Stand-1 (ETS-1) are presented. The evaluation concerns the performance envelope for the selected subsonic turn ejector system in the Nuclear Exhaust System (NES) for the ETS-1. The experimental tests were conducted on 1/8 scale models. As a result of the data obtained through this experimental and analytical evaluation, the design implications for the NES for ETS-1 have been drawn. (auth)

15758 COOLDOWN REQUIREMENTS FOR NUCLEAR ROCKET MISSIONS. Fenstermacher, Charles (Los Alamos Scientific Lab., N. Mex.); Oakley, Donald T. J. Spacecraft Rockets, 4: 117-19(Jan. 1967).

Estimates of the effects of restart capability on nuclear rocket engine operation and mission applications are presented. It is concluded that restart requirements can lead to weight penalties comparable to the initial engine weight and through relative thrust degradation to equivalent weight penalties exceeding the engine weight. (J.R.D.)

Process Heat and Desalination Reactors

Refer also to abstract 15681.

15759 (BNL-10628) ECONOMICS OF A DUAL CYCLE CHEMONUCLEAR NITROGEN FIXATION PROCESS. Beller, Morris; Epel, Lester G.; Steinberg, Meyer (Brookhaven National Lab., Upton, N. Y.). Sept. 1966. Contract AT(30-2)-Gen-16. 33p. (CONF-670201-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Symposium on the Impact of Low Cost Nuclear Power and Chemical Industry, Houston, Tex.

An economic and design study for production of fixed N is presented which utilizes both direct fission fragment energy and indirect thermal energy from a nuclear reactor. The results indicate that the method can prove competitive with conventional N fixation techniques provided that G-values of at least 6.0 can be achieved, and that plant capacities are in the order of 3000 tons/day fixed N. The primary areas requiring further development for the process are pointed out. (auth)

15760 (TID-23511) THE OAK RIDGE NATIONAL LABORATORY CONCEPTUAL DESIGN OF A 250-MGD DESALINATION PLANT. Progress Report No. 214. (Oak Ridge National Lab., Tenn.). Sept. 1966. Contract W-7405-eng-26. 332p. Dep. mn. GPO.

Results of an exploration in depth into the economic and engineering factors that affect cost and performance of large seawater evaporators using the multistage flash process are presented. A design was developed using near-term technology that could be used in construction for an overall cost of $103,000,000. The cost corresponds to a unit capital cost of 41.2 cents per daily gallon of capacity. If this evaporator were coupled with a nuclear energy source of the heavy-water type to form a dual-purpose station, it is estimated that the water cost would be about 15.7 cents per thousand gallons. A compact building was designed that leads to a lower construction cost, lower land cost, and other benefits. The study showed that the optimum number of levels increased with the capacity of the plant. The use of concrete for the evaporator shell was also found to produce an important cost advantage, even when the concrete shell is protected by a metal liner to prevent inleakage. Expansion and thermal stresses were considered to verify that the concrete structure could be built by standard techniques and would perform reliably. The use of long continuous condenser tubes that pass through many stages permitted large

cost savings over short-tube condensers when combined with procedures for producing and testing tubes on site and the utilization of automated systems for installing them in the plant. With the aid of supplementary design studies, a detailed computer model was constructed that can be used to calculate performance, construction, and operating costs of the multilevel flash evaporator over a range of sizes and operating conditions. The code is used to produce a cost-optimized plant for each condition, with as many as 11 variables being optimized at once, and with 58 basic systems or components of the plant being altered for each case. The code was used to study the changes in water costs resulting from variations in plant parameters, such as the ratio of water to power output, size of plant, overall heat transfer coefficient, temperature of seawater, and many others. The code should be useful in preliminary studies of proposed desalting projects, since the input information is fully documented and can be changed readily to fit any given case. The reference design has Cu–Ni alloy tubes, steam-turbine pump drives, multilevel construction, and five separately operable 50-Mgd modules or trains. Supplementary design information was also developed and cost estimates were made for a plant with Ti tubing, a single-level plant, a single-module 250-Mgd plant, a multieffect multistage plant, and electric pump drives. The most important data on the reference design are presented tabularly. (auth)

15761 THE PROBLEM OF DESALINIZATION OF SEA WATER AND NUCLEAR ENERGY. Biondi, Leonardo (Montecatini, Milan). Elettrotechnica, 53: 550-3(1966). (In Italian).

The development of consumption of water in Italy is reviewed and factors defined which allow estimation of the dimensions of a desalinization plant. Within the next few years plants of capacity 20,000,000 m^3/year will be desirable. These will have 100 MW power and will be fed by single-stage sources of heat. In the more distant future, it may be more convenient to use double-stage plants of greater capacity. Various heat sources and proposals for nuclear-energy desalinization plants in other parts of the world are examined. A low-temperature reactor in an Italian project is briefly described; this is refrigerated and moderated with an organic liquid and fed by enriched U encased in Al. (BBB)

Research and Test Reactors and Critical Assemblies

Refer also to abstracts 14373, 14682, 15657 and 15670.

15762 (ANL-7161) FARET IN-CORE INSTRUMENT DEVELOPMENT. Popper, Glenn F.; Knox, Alvin E. (Argonne National Lab., Ill.). July 1966. Contract W-31-109-eng-38. 75p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Development of instruments to measure fuel-pin and coolant temperatures, coolant flow in fuel assemblies, fission gas pressure buildup in fuel pins, and core neutron and gamma fluxes is described. Information is included concerning design of the FARET facility. (J.R.D.)

15763 (BNWL-SA-464) FAST FLUX TEST FACILITY PROGRAM. Astley, E. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 22, 1965. Contract AT(45-1)-1830. 15p. (CONF-660502-2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London.

Evaluation of concepts for the facility is in progress. The basic FFTF concept calls for a highly specialized fast reactor to serve as an irradiation testing facility for a wide variety of fuels and reactor materials. Provisions are included for pre-irradiation and post-irradiation testing and for examination of materials to assure that test data are quickly and accurately acquired. (J.R.D.)

15764 (CONF-660221–, pp 287-90) ANALYSIS OF UNIFORM LATTICE EXPERIMENTS WITH THORIA–URANIA FUEL IN HEAVY WATER AND LIGHT WATER AS MODERATORS. Bhatia, H. K. (Atomic Energy Establishment, Trombay (India)).

The METHUSELAH-I and CAROL codes for $ThO_2-^{235}UO_2$ or $ThO_2-^{233}UO_2$ lattices with heavy or light water as moderator were assessed. Experimental bucklings were used to calculate the K_{eff} for uniform critical lattice experiments performed at Argonne National Laboratory, Brookhaven National Laboratory, and the Babcock and Wilcox Company. (H.D.R.)

15765 (CONF-661019–10) RECENT FAST CRITICAL EXPERIMENTS IN THE MSCA AND 710-CE. Petersen, G. T.; Kunze, J. F.; Wall, I. B.; Hallam, J. W.; Henderson, W. B.; Warzek, F. G. (General Electric Co., Pleasanton, Calif. Nuclear Technology Dept.). Oct. 1966. Contracts AT(04-3)-189; AT(40-1)-2847. 28p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From International Conference on Fast Critical Experiments and Their Analysis, Argonne, Ill.

The fast core of the Mixed Spectrum Critical Assembly (MSCA) or the Vallecitos Atomic Laboratory, contains a loading of enriched UO_2, natural UO_2, and Inconel. The neutron spectrum in this assembly is spatially asymptotic and representative of a dilute fast ceramic reactor. Measurements reported include fission rates of ^{233}U, ^{234}U, ^{235}U, ^{236}U and ^{237}Np. Neutron life-time determined by pulsed neutron and 1/V poison substitution, and reactivity worths determined by pile oscillator and direct period measurements are reported. At the Idaho Test Station, work in the 710-CE concentrated on small, hard spectrum, refractory metal critical experiments related to space power reactor applications. Be reflected cores in the 20 to 50 liter range, containing essentially equal volume mixtures of W, fully enriched U metal and Ta are studied. Data from the first basic critical experiment include central fission ratios, reflector effects on power distribution and neutron lifetime, and relative reactivity worths. (auth)

15766 (N-66-19220) SECOND ORDER CORRECTION TO THE AVERAGE EXTRAPOLATION LENGTH. Inonu, E. (Cekmece Nuclear Research Center, Istanbul (Turkey)). 1963. 15p. (CNAEM-8). CFSTI $3.00 cy, $0.65 mn.

A first-order expression for the average extrapolation length in bare thermal reactors was given previously on the basis of a many-group calculation. This calculation is extended to second order and a complicated correction term is obtained. The results are analyzed and simplified here by considering the limit for continuous slowing down. It is shown that the second order correction is of the order of $\bar{d}/\bar{R}$, where $\bar{d}$ is the first order average extrapolation length and R is a length which characterizes the size of the reactor. (STAR)

15767 (N-66-26822) EXPERIMENT DESIGN MANUAL AND HAZARDS ANALYSIS: PLUM BROOK REACTOR FACILITY. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). May 1964. 52p. (NASA-CR-75303; WANL-TNR-119 (Rev.1)). CFSTI $3.00 cy, $0.65 mn.

A design manual and hazards analysis are presented for an in-pile water cooled capsule in the HT-1 tube of the Plum Brook reactor facility. The basic purpose is to provide information which will assist in the selection of materials and components for incorporation in the NERVA reactor experiment (NRX). The water-cooled capsule tests required items in a high radiation environment, and are considered the closest available to the actual NRX levels. A primary consideration is that many of the radiation effects which are of importance are those associated with dose rate rather than total integrated dose. (STAR)

15768 (N-66-33021) CRITICAL MASS STUDIES WITH THE NASA ZERO POWER REACTOR II. III. HETEROGENEOUS ARRAYS OF CYLINDRICAL VOIDS. Fox, Thomas A.; Mueller, Robert A.; Ford, C. Hubbard (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Aug. 1966. 25p. (NASA-TN-D-3555). CFSTI $3.00 cy, $0.65 mn.

The NASA Zero Power Reactor II (ZPR-II) has been used to determine experimentally several critical cylindrical configurations of aqueous fuel solutions that contain heterogeneous arrays of voids. These voids are cylindrical, are symmetrically arranged parallel to the axis of the reactor, and extend the height of the core. The study covered a wide range of highly enriched aqueous UO_2F_2 fuel concentrations. The specific reactor void configurations consisted of symmetrical arrays of 1, 7, 19, 31 and 37 tubes approximately 7.6 cm in diameter arranged in hexagonal geometry with pitches of 9.652 or 10.922 cm. In addition to the critical mass and geometry, data are presented on the thermal neutron flux distributions in the central radial plane, and on the variation of void reactivity importance with radial position. These data explain qualitatively some of the reactivity effects associated with the different void spacings. (STAR)

15769 (NP-16463) CARTE DE FLUX THERMIQUE DU COEUR 32-3-F "COEUR TRITON". Note Siloette No. 24. (Thermal Flux Chart of the 32-2-F Triton Core. Siloette Note No. 24). Pattou, A. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Mar. 26, 1965. 21p. (In French). (INT/Pi(NT)906-51/65). DTIE.

The thermal flux pattern for the 32-2-F triton core was calculated. The core configuration and the irradiation conditions are given. The measurement points are indicated and the values of the Cd ratios are determined. The mean thermal flux in the individual elements was measured. The calibration of the chambers is outlined. The mean flux per watt in the element and the maximum flux in the core are determined. The effect of Al blocks on the thermal flux was determined. (J.S.R.)

15770 (ORNL-tr-1563) CONTRIBUTIONS OF THE ISPRA CENTER TO STUDIES ON THE BEHAVIOR OF REACTOR COOL-

ANTS AND COMPONENTS UNDER ACCIDENT CONDITIONS. Finzi, S.; Grass, G. Translated for Oak Ridge National Lab., Tenn., from paper (EUR/C/IS-1347/66-f) presented to the 2nd meeting of the CREST Committee, Paris, November 2–4, 1966 (Part 2). 15p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80 mf.

A program concerning the behavior of coolants in the case of flash vaporization, which is a possible cause for the ejection of coolant from a channel or from the reactor vessel, was undertaken at ISPRA. The research includes a measurement of the ejection velocities and a study of the amplitudes and frequencies of corresponding pressure and temperature transients caused by boiling or recondensation. The two reactor systems under study were the light-water and the sodium-cooled fast reactors. The second part of the study concerned the behavior of reactor components and structures under accident conditions. Studies were carried out on the formation and propagation of pressure waves in water, organic liquids, air and mixture in a single-phase and binary system, bounded by various geometries. The influence of the deformation rate on the mechanical properties of steels for pressure vessels, Zircaloy and SAP was observed. (J.C.W.)

15771 STATUS REPORT ON LOFT. Wilson, T. R. (Phillips Petroleum Co., Idaho Falls, Idaho). Nucl. Safety, 8: 127-33 (Winter 1966-1967).

The LOFT project was established in 1962 to develop information on the complex phenomena associated with loss-of-coolant accidents in a water-cooled power reactors. The principal activities since the inception of the project have been the formulation of an engineering test program, the design of a field-scale facility in which to investigate accidents, and theoretical and experimental studies pertinent to the program. Design of the reactor, a 50-MW(t) pressurized-water system, is 95% complete, and completion of construction of the facility is expected in early 1968. The experimental program will consist in containment leakage tests, blowdown tests, reactor tests and operation, loss-of-coolant tests, and postaccident examinations. Theoretical studies under way in support of this program consist in analyses of blowdown, core heatup and meltdown, and fission-product behavior. (auth)

15772 OPERATIONAL PROBLEMS WITH THE HEALTH PHYSICS RESEARCH REACTOR. Gilley, L. W.; Holland, L. B.; Poston, J. W.; Ward, D. R. Nucl. Safety, 8: 179-82(Winter 1966-1967). (ORNL-P-2445).

The HPRR is a bare-metal unmoderated reactor that is used to produce short (~50-μsec) intense pulses of neutrons in self-limiting nuclear excursions or to produce a constant flux of neutrons at power levels of 10 kW or less in the steady-state mode for dosimetry and biomedical research at ORNL. Although the reactor has basically performed according to design since operations were initiated at ORNL in 1963, several problems that required time and effort to rectify were encountered. These problems are discussed, and the information necessary to isolate the cause of one problem, the scatter in the burst size, is outlined. (auth)

15773 FACTORS INFLUENCING THE EFFECTS OF REACTOR RADIATIONS ON ELECTRICAL COMPONENTS. Anno, J. N. (Battelle Memorial Inst., Columbus, Ohio). Nucl. Appl., 2: 371-8(Oct. 1966).

Experiments performed at the Battelle Research Reactor indicate that the output of electrical components is influenced by a radiation environment in several ways. Gamma radiation produces electron emission from metals, varying from 0.38×10^{-16} A/cm^2 per R/h for Al to 6.1×10^{-16} A/cm^2 per R/h for U. The gammas also ionize residual gas in the experimental test section and produce heating in the components. Thermal neutrons affect electrical components principally through reactions leading to the emission of beta particles. Fast neutrons and electrons (from various sources) sputter atoms from the surface of materials. The resistance of insulators may be drastically altered in a radiation field, principally by photoconduction. The magnitude of several of these effects of radiation is illustrated by a simple in-pile experiment. (auth)

15774 ASYMPTOTIC SPACE–TIME DECAY OF MONOENERGETIC NEUTRONS IN A MULTIPLYING HOMOGENEOUS MEDIUM. PART 1. THE CASE $k_\infty = 1$. Boffi, V. C.; Trombetti, T. (CNEN, Bologna). Energ. Nucl. (Milan), 13: 539-53(Oct. 1966).

The asymptotic space-time behavior of the total flux of monoenergetic neutrons, which is contributed by the polar singularities of its double transform, is studied in the case of an infinite homogeneous multiplying medium which only one group of delayed neutrons, plane geometry, isotropic scattering in the laboratory system and infinite plane pulsed source. The detailed application is the proposed method to the case when $k_\infty = 1$, that is when the infinite reactor is just critical. (auth)

15775 GAMMA DOSIMETRY IN THE CORE OF THE WWR-S RESEARCH REACTOR. Novotny, Josef; Zajic, Vladimir (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Jad. Energ., 12: 441-4(Dec. 1966). (In Czech).

By means of the radiocolorization of special dosimetric glasses the fields of γ radiation were investigated in the channels of a reactor water loop and a reactor water sond being used for the research of corrosion of materials under the influence of nuclear reactor radiation. The measurements were performed in the zone of the reactor core. The dosimetric glasses were sensitive in the range of 10^4 up to 5×10^6 R. In the channel of the reactor water loop the γ radiation intensity was 2×10^6 R/min. In the channel of the reactor water sond the intensity was 1.3×10^5 R/min. The work carried out contributed not only to the verification of the applied measuring method but also to the determination of fundamental characteristics of the WWR-S reactor core. (auth)

15776 FUEL ELEMENTS LEAK CONTROL METHOD AT WWR M REACTOR OF THE PHYSICS INSTITUTE OF THE UKRAINIAN ACADEMY OF SCIENCES. Barchuk, I. F.; Pilipets, D. T. At. Energ. (USSR), 21: 514-15(Dec. 1966). (In Russian).

The method of V. I. Polikarpov et al., developed in 1962 for checking leaking fuel elements of the VVR-M reactor at the Institute of Physics of the Ukrainian Academy of Sciences, was found to be relatively insensitive. A new method is therefore proposed; it involves concentrating the leaking fission product gases from the faulty elements in an ionization chamber, reducing the volume by a factor of 100. The leak rate is determined from the current generated in the ionization chamber. An underwater vacuum chamber placed near the core is used for carrying the tests, at 75 to 80°C, the usual temperature of the fuel elements at the time of the weekly shutdown of the reactor. Before reaching the ionization chamber, the gases pass through a filter which retains the moisture and the aerosols; the activity of these components is measured separately. The device makes it possible for an operator to carry out a determination in about one hour. (TTT)

15777 REPAIR WELDING IN RADIOACTIVE AREAS ON THE FUEL PLUG OPENING OF THE LOWER PLUG OF JRR-2 REACTOR. Abe, Yasuhiro (Japan Atomic Energy Research Inst., Tokyo); Hashimoto, Tsunataro. Mitsubishi Denki Giho, 40: 1588-90(Oct. 1966). (In Japanese).

Leakage of heavy water was found in the JRR-2 reactor. Repair work was begun by disassembling two months later. Strain inside the lower fuel plug opening was removed. MIG welding was performed on cracks at a welded section, and mending of part of the upper plug was done. The work involved special caution against the danger of radiation. Proceedings are described and the process of safeguarding the personnel is reported. (NSA of Japan)

15778 CALCULATION OF THE SHIELDING OF A NUCLEAR REACTOR BY MULTIPLE LAYERS OF IRON AND WATER. Rashed, R. A. (Christian-Albrechts-Univ., Kiel). Atomkernenergie, 11: 373-8(1966).

The Cooper, Jones and Horton-model was applied for calculating the neutron attenuation in the iron–water shield arrangement 4 ESTAGROP at Geesthacht. In addition, the group diffusion parameters of concrete were obtained by comparing the diffusion theory results with the results obtained. (auth)

15779 THERMAL SPECTRUM MEASUREMENTS IN SLIGHTLY ENRICHED URANIUM, LIGHT-WATER-MODERATED LATTICES, BY THE LUTETIUM ACTIVATION METHOD. Tassan, S. Nucl. Sci. Eng., 26: 271-6(1966).

Thermal spectrum measurements in 1% enriched U, 0.387-in. dia rod lattices, light water moderated, have been performed by the Lu activation method in order to test the usefulness of this technique in not-well-thermalized lattices. ^{164}Dy and ^{175}Lu were used as reference thermal-neutron detectors. The experimental results are presented as the average values of the normalized (lattice/Maxwellian) activation ratios of ^{176}Lu/Dy and ^{176}Lu/^{175}Lu with the pertinent Cd-ratios, in the fuel and in the moderator over the H_2O/U range from 1:1 to 4:1. The agreement with the results of a calculation performed using the THERMOS code is satisfactory. It is concluded that the ^{176}Lu/Dy set appears to be adequate for the thermal spectrum analysis of light-water-moderated lattices, while the ^{175}Lu/Dy set can provide rather accurate integral data for the epithermal component of the neutron spectrum. (auth)

15780 CALCULATING SPACE-DEPENDENT REACTOR TRANSFER FUNCTIONS USING STATICS TECHNIQUES. Cohn, Charles E.; Johnson, Robert J.; Macdonald, Robert N. Nucl. Sci. Eng., 26: 198-206(1966).

A method has been developed by which statics techniques can be used to calculate source transfer functions in the multigroup,

multidimensional approximation. With the flux resolved into steady and fluctuating components, the time-dependent neutron balance equations are satisfied by the fluctuating part alone. Assuming that the external source and the flux response are sinusoidal, the original time-dependent equations transform into a set of complex equations dependent on space and frequency but independent of time. Separating the equations into real and imaginary parts yields coupled, inhomogeneous differential equations (two for each group). These can be solved by well-known statics techniques for the real and imaginary components of the complex amplitudes of the fluxes, in turn yielding the gain and phase shift for each frequency of interest. This method was applied to the NORA reactor for which the space-dependent transfer function had been determined experimentally. The two-group telegrapher's equations were programmed for one-dimensional cylindrical geometry and the difference equations solved by direct matrix inversion and also by iterative techniques. Results of the calculations closely reproduce the reported experimental results for gain and phase shift. (auth)

15781 CALCULATION OF SPACE DEPENDENT EFFECTS IN PILE OSCILLATOR AND REACTOR NOISE MEASUREMENTS. Johnson, R. J.; Macdonald, R. N. (Georgia Inst. of Tech., Atlanta). 27p. (CONF-660206-15). ORAU. Gmelin, AED-CONF-66-014-17.

From Symposium on Neutron Noise, Waves and Pulse Propagation, Gainesville, Fla.

A technique was described by which space-dependent zero-power reactor source transfer functions could be calculated from the two group telegrapher's equations, by transforming them into coupled, complex equations dependent upon position and frequency but independent of time. These equations were then solved (in one dimension) by standard statics techniques for the reactor's response to a fluctuating source. This method was extended to a two dimensional model for a source located off the core center-line. Good qualitative agreement between experiment and theory is achieved. In addition, equations are developed which allow the method to be used to calculate the reactor's response to a distributed noise source. (auth)

Production Reactors

Refer also to abstracts 15666 and 15670.

15782 HIGH-FLUX OPERATION VIA ANALOG COMPUTER. Occhipinti, E. S.; Mix, P. E.; Stutheit, J. S.; Field, F. R. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Nucl. Appl., 2: 363-70(Oct. 1966).

An analog computer was developed to measure the safety factor against film-boiling burnout of reactor fuel surfaces. The instrument was used at the Savannah River Plant as an aid in manual control of power in one heavy-water-cooled and -moderated production reactor which operated with a specific power of over 220 kW/g of ^{235}U and at neutron flux levels up to 6×10^{15} n/(cm^2 sec). (auth)

Reactor Components, Fuels and Accessories

15783 (BNWL-131E) FABRICATION COSTS FOR PLUTONIUM FUEL ELEMENTS. PART E. THE VARIATION IN FABRICATION COST WITH SOME FUEL DESIGN PARAMETERS. Bloomster, C. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 1967. Contract AT(45-1)-1830. 22p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The effect on fabrication cost of some fuel design parameters is analyzed and a model permitting fabrication costs to be estimated for a wide variety of fuel designs is constructed. Variable fabrication costs for vibratory compacted PuO_2-UO_2 fuel elements for thermal reactors were analyzed and shown to vary in a consistent manner which may serve as a basis for predicting fabrication costs for other similar geometries. (M.L.S.)

15784 (BNWL-312) URANIUM PRICE SCHEDULES BY UCOST CODE COMPUTATION. Deonigi, D. E.; Horton, P. A.; Nail, J. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 1966. Contract AT(45-1)-1830. 168p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The UCOST code has been used to calculate the price of U of various enrichments, based on the costs of feed material on the price of separative work, and on the credit for waste material. Data are tabulated. (auth)

15785 (BNWL-CC-483) COMPUTER CONTROL OF A FUEL FABRICATION FACILITY. Burnham, J. B.; Walker, R. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1966. Contract AT(45-1)-1830. 27p. DTIE.

A simple program was written for a PDP-7 digital computer. This demonstrated the ability of such a computer to keep an instantaneous record of all fissionable materials. It was also able to signal a warning when the critical limits of a given hood would be exceeded as the result of a proposed transfer. The program also prevented using the wrong format for entering data. Comprehensive requirements were developed for all of the foreseeable uses to which a computer system could be put. Estimates were made of the total cost of the various systems necessary to meet these requirements. (auth)

15786 (NP-16490) NOTE D'INFORMATION SUR L'EMPLOI DES CALCULATEURS EN TEMPS REEL. CONTROLE DU REACTEUR ET TRAITEMENT D INFORMATION DES EXPERIENCES ASSOCIEES. (Studies on the Use of Calculators in Real Time. Reactor Control and the Treatment of the Information From Associated Experiments). Gariod, R.; Girod, J. J. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Nov. 29, 1965. Revised Feb. 1, 1966. 63p. (In French). Dep. mn.

The use of computers for centralized reactor control and processing of data from associated experiments is presented. A possible configuration is indicated for such a centralized system beginning with a quantitative knowledge of the problem. The steps which should be followed are the formulation of the problems posed by the control of the reactor operation and the auxiliary installation, the acquisition of experiment data, and the processing of these data. The problems posed by the utilization of computers are outlined. (J.S.R.)

15787 (WAPD-TM-312(Add.1)) PLASTIC-SASS: A FORTRAN IV COMPUTER PROGRAM FOR STRESSES AND DEFLECTIONS IN A REACTOR SUBASSEMBLY UNDER THERMAL, HYDRAULIC, AND FUEL EXPANSION LOADS. Long, W. D. Jr. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Dec. 1966. Contract AT(11-1)-Gen-14. 6p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

PLASTIC-SASS-3 is described. This program can be used in analyses in which assignment of different growth characteristics to each region of subassemblies and specification of anisotropic behavior to the material of each region is required. (J.R.D.)

15788 (ORNL-tr-1466) EXECUTIVE ORDER ON NUCLEAR REACTOR CONTAINERS OF PRESTRESSED CONCRETE. Translated for Oak Ridge National Lab., Tenn., from Arrete sur les Caissons de Reacteurs Nucleaires en Beton Precontraint. 13p. Dep. mn. JCL $1.60 fs, $0.80 mf.

The order is divided into articles in which regulations are established concerning administrative procedures, design and planning of prestressed containers, materials and fittings used, calculation methods, tests of mockups and scale models, construction methods, and final testing. (J.R.D.)

15789 PASSAGE OF REACTOR NEUTRON RADIATION THROUGH NON-HYDROGENOUS MEDIA. Tsypin, S. G.; Sinitsyn, B. I.; Daruga, V. K. J. Nucl. Energy, Pt. A and B, 20: 851-61 (Oct. 1966).

An examination is made of the results of studies of neutron passage through non-hydrogenous homogeneous materials and mixtures. The relaxation lengths obtained for neutrons of different energy groups are discussed. It is shown that, with certain assumptions, the magnitude of the attenuation of a flux of neutrons of the upper energy group ($E_n \geq 3$ MeV) in a non-hydrogenous medium can be obtained from empirical expressions using constants such as the removal cross section (σ_{rem}), the cross section obtained from the inverse relaxation length (σ_1/λ), and the asymptotic cross section. The values of these constants are given. (auth)

15790 NUCLEAR FUEL SUPPLIES AND REQUIREMENTS IN THE U.S. Faulkner, Rafford L. (Atomic Energy Commission, Washington, D. C.). Nucl. Energ., 250-2(Nov.-Dec. 1966).

The projections of the growth of nuclear power and the relationship of the resulting U requirements to U resources are discussed. It is assumed that atomic power plants will work as well as predicted, that cool producers and shippers find it impossible to make further cost reductions resulting in much cheaper atomic power such that no further fossil-fueled plants have an advantage over nuclear-fueled plants where lower load factors and generating units of smaller sizes are involved. (J.C.W.)

15791 DETERMINATION OF LATTICE PARAMETERS OF D_2O-MODERATED SYSTEMS FROM PULSED AND STATIC NEUTRON MEASUREMENTS. Parkinson, T. F.; Diaz, N. J.; Perez, R. B. (Univ. of Florida, Gainsville). Nucl. Energ., 262-70 (Nov.-Dec. 1966).

Experiments are described in which both the neutron die-away method and the static exponential method have been applied to a

variety of natural-U, D_2O-moderated lattices. Three different fuel assemblies were used and data were obtained in both bare and side reflected systems. From the measured decay constants, k_∞ the infinite reproduction constant, and B^2_m, the material buckling, were evaluated. Theoretical studies were made of the multigroup, multiregion subcritical and the experimental decay constants for both bare and reflected systems agreed well with a two-region, two-group model. From the combined pulsed and static experiments, the dispersion law for multiplying media was derived. (auth)

15792 DETERMINATION OF THE ECONOMIC SIZE OF A VOLUME COMPENSATOR PROVIDED FOR A NUCLEAR POWER PLANT WITH PRESSURIZED-WATER REACTOR. Fratzscher, W.; Bock, J. (Technical Univ., Dresden). Kernenergie, 9: 285-9(Sept. 1966). (In German).

In contrast to volume compensators working with N_2 as the compensating medium volume compensators with saturated steam offer two possibilities to reduce undesired increases of pressure because of the thermal expansion of the coolant: compression of the overhead steam or injection of water. The size of the saturated-steam volume compensator is shown to be dependent on the mode of dividing in the two parts of compensation. But economic studies based on an "ordered compensation diagram" prove that an optimum ratio exists minimizing the total cost of the volume compensator. A method of determining this optimum by using simplifying presumptions with respect to the cost is described. (auth)

15793 FUEL ELEMENT FABRICATION FOR THE DRAGON REACTOR EXPERIMENT. Price, M. S. T.; Gough, J. R. G.; Horsley, G. W. (United Kingdom Atomic Energy Authority, Winfrith, Eng.). J. Brit. Nucl. Energy Soc., 5: 361-82(July 1966).

The concept of a fission product-emitting fuel was discarded in favor of coated particle fuel. The rapid advances made in this new branch of fuel element technology have transformed the economics of high-temperature gas-cooled reactors and have led to the successful fabrication by the Dragon Project of fuel and fuel elements for the initial charges of the Dragon Reactor Experiment. This relatively large scale operating experience, including the handling of 93% enriched U, was entirely satisfactory and without incident. The manufacture of coated particle fuel is well suited to large scale production. An assessment of fuel fabrication for an initial 2000 MW(e) construction program, which has had the advantage of being based on experience within the Project, is useful as a guide to the cost of the various parts of the manufacturing process. It is evident from the cost analysis that fabrication is less than 30% of the cost of the fuel. Because of this it is considered that the trend in coated particle fuel manufacture will be towards the product with the best guarantee of performance. (auth)

15794 FUEL CYCLES FOR POWER REACTORS. Schroeder, E.; Blomstrand, J. H.; Bruneder, H. (United Kingdom Atomic Energy Authority, Winfrith, Eng.). J. Brit. Nucl. Energy Soc., 5: 408-28(July 1966).

In addition to the high efficiency and the excellent neutron economy of high temperature reactors, the freedom to utilize Pu or ^{235}U as fissile material and ^{238}U or Th as fertile material in all possible combinations, is an additional advantage of this reactor type. The results of survey calculations are summarized on fuel cycle performance and cost for these combinations and various fuel management schemes, ranging from batch loadings over part load system to continuous charge/discharge operations; the latter on-load. Under the present economic conditions the reactor would be best utilized with a feed breed cycle with continuous charge/discharge of the feed. Assuming equal charges for fissile materials, this cycle gives fuel costs of 0.095 d/k Whr with ^{235}U feed and Th breed and 0.112 d/k Whr with Pu feed. When reprocessing facilities are available fuel cycle costs can be further reduced for reprocessing cost below £200/kg heavy metal. (auth)

15795 REACTOR MATERIALS. Volume 9, Number 3. Simons, E. M.; Keller, D. L.; Endebrock, R. W. (eds.). A Quarterly Technical Progress Review published for the Division of Technical Information, USAEC. Columbus, Ohio, Battelle Memorial Inst., Fall 1966. 73p. GPO $0.70 Domestic, $0.90 Foreign.

New published developments in reactor materials are reviewed. The reviews are divided into five sections: fuel and fertile materials, moderator materials, nuclear poisons, cladding and structural materials, and special fabrication techniques. Separate abstracts were prepared for each section. (B.L.M.)

For abstracts of individual sections see: 14788, 14808, and 15796–15798.

15796 FUEL AND FERTILE MATERIALS. Reactor Mater., 9: 151-65(Fall 1966).

Recent developments in the field of fuel and fertile materials for nuclear reactors are reviewed in some detail. U metal and alloys as well as α-phase and dilutes U alloys are discussed. Solubility of Nb in liquid Pu at temperatures of 700 to 950°C is shown in tabular form. The properties of U–Pu–Ti, U–Pu–Zr, and U–Pu–Fe alloys are reviewed. A discussion of the preparation of Pu compounds for the preparation of high-density pellets for use in sintered fuels is presented. The variation of the thermal conductivity and thermoelectric power of Th with varying temperature is presented graphically. Cermet fuels having over 50 volume % ceramic phase and dispersion fuels having <50 volume % ceramic phase are reviewed. Coated particle fuel materials, particularly those coated with pyrolytic graphite, are discussed. This discussion also includes some information on irradiation and evaluation of coated-particle fuels. Properties, behavior, and fabrication of uranium oxides, thorium oxides, uranium carbides, uranium nitrides, uranium phosphides, uranium sulfides, and uranium arsenides are reviewed. Corrosion studies of the fuel alloys and irradiation effects on the fuel materials are reviewed. (77 references). (B.L.M.)

15797 MODERATOR MATERIALS. Reactor Mater., 9: 166-70(Fall 1966).

Certain radiation effects on graphite as a reactor moderator material are reviewed in some detail. Be and its alloys are discussed as reactor moderator material from the standpoints of purification, fabrication, joining, and irradiation effects. Some crystalline transformations of BeO are discussed. The solid hydrides, ZrH_4, hydrided Zr-alloys, and LiH are discussed. (21 references.) (B.L.M.)

15798 NUCLEAR POISONS. Reactor Mater., 9: 171-3(Fall 1966).

Hf, dispersion, and nonmetallic poison materials are discussed. The effects of varying O content on the hardness of Hf and some tensile-test results for Hf–O systems are tabulated. Some observations concerning evidence of damage, swelling, or nonuniform burnup for a Eu_2O_3 stainless steel-clad control rod due to extended irradiation are presented. Three refractory metals, Cr, Mo, and W, were evaluated as binders for ZrB_2. Certain metallographic properties of HfO_2–ZrO_2 and phase-equilibrium studies for the system WO_3–B_2O_3 are reviewed briefly. (6 references.) (B.L.M.)

15799 NUCLEAR REACTOR WITH INTERNAL SUPERHEATING. Azuma, Masao (to Hitachi, Ltd.). Japanese Patent 1966-2277. Feb. 15, 1966. Filed Dec. 28, 1962.

The reactor consists of three main core regions: the outer coolant loop, middle transient, and central steam-superheating regions. By adjusting the flow-rate through the central superheating region, the control of the reactor is attained. To flow part of the cooling fluid in each region to other regions, a feedwater loop from the outlet of the superheating region to the outlet of the boiling region is installed. A device for adjusting the flow-rate in the loop according to the temperatures in the reactor core is installed. (NSA of Japan)

15800 FUEL ELEMENTS. Hayashi, Tsutomu (to Hitachi, Ltd.). Japanese Patent 1966-320. Jan. 12, 1966. Filed Feb. 23, 1963.

The fuel elements are vibrated by the force of coolant, which may result in the contact with another element. Coolant will not flow through such places, leading to the melting of the fuel elements. Plates, which are bent to form rectangular channels at suitable intervals, are piled one upon the other, forming the structure of a lattice. Fuel elements are inserted in the channels obtained by these bent plates following a zigzag course horizontally and vertically. The remaining channels are used as passages of the coolant. (NSA of Japan)

15801 DEVICE FOR FIXING A CONTAINER IN A TRANSPORT TUBE. Kanamori, Naokazu (to Hitachi, Ltd.). Japanese Patent 1966-2326. Feb. 16, 1966. Filed Jan. 12, 1963.

A container for a fuel transport tube is proposed. A fuel-transport tube running through the shield of a reactor has an opening for the charge and discharge of reactor fuel. The fuel is transported through the tube in its container. The container has an opening corresponding to the opening of the transport tube. The container travels through the transport tube by means of a rope, and so it is difficult to position the container properly at the upper or lower end of the tube. In the method proposed, the container is provided with (suitable) rollers and the transport tube with the guide mechanism for the rollers. By utilizing the travel motion of the container in the tube the container can be fixed at a given position and direction. (NSA of Japan)

15802 DEVICE FOR RELEASING A REACTOR SAFETY-ROD. Iwai, Shozo (to Mitsubishi Atomic Power Industries, Ltd.). Japanese Patent 1965-27275. Nov. 30, 1965. Filed Mar. 24, 1962.

An electromagnet can be made small in size, and yet the holding or releasing of a safety rod can be accomplished both safely and reliably. The smooth and rapid release of the rod can be achieved. The device consists of an intermediate member, inserted around the support rod of a safety rod, which is movable in the axial direction. A contact member is driven by the electromagnet and holds up the intermediate member when it engages with the latter, and releases it down when disengaged. A hook, supported by a fixed member, engages with the safety-rod support rod in the normal condition (the holding-up condition). The intermediate movable member and the hook are so arranged that when the former drops the hook disengages from the rod support, thereby permitting the safety rod to drop down for reactor scram. (NSA of Japan)

15803 NUCLEAR REACTOR FUEL ELEMENT. Hildebrand, G. E. H. (to Fulcrum Aktiebolag). Canadian Patent 743,203. Sept. 20, 1966.

A fuel element consisting of a core of uranium dioxide surrounded by a mantle of U metal is described. It may be round with or without fins, or oval in cross section. The core may be a solid rod or a column of slugs. Such arrangement is claimed to have a higher U density than a conventional fuel element with a lower resonance absorption. The heat transfer properties and mechanical stability are improved. The space between the core and mantle is filled with a gas or solid of low neutron cross section. (F.S.A.)

15804 IMPROVEMENTS IN OR RELATING TO FUEL ASSEMBLIES FOR NUCLEAR REACTORS. Guild, James Carrie (to United Kingdom Atomic Energy Authority). British Patent 1,057,142. Feb. 1, 1967. Filed Jan. 9, 1963.

A fuel assembly is described which comprises a base support for stacked fuel elements, a tie rod extending from the base support through the fuel elements, and an upper support for the rod. In this way the fuel stacks are suspended in the reactor core. Specifications and drawings are included. (J.R.D.)

15805 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS AND TO FUEL ELEMENT CONSTRUCTIONS THEREFOR. Le Foll, Jean (to C. A. Parsons and Co. Ltd.). British Patent 1,057,394. Feb. 1, 1967. Filed Feb. 21, 1963.

Design of a reactor is described in which the moderator has provision for housing plate-type fuel elements in such a manner that coolant flows over them axially. The arrangement allows for increased heat transfer and greater thermal efficiency. Design of fuel plates is also included in the overall design. Specifications and drawings are included. (J.R.D.)

15806 IMPROVEMENTS IN INSTALLATIONS FOR HEAT TRANSFER WITHIN PRESSURE VESSELS FROM HEAT SOURCES TO HEAT EXCHANGERS. (to The Babcock and Wilcox Co.). British Patent 1,056,080. Jan. 25, 1967. Priority date Aug. 28, 1962, United States.

Design of an improved heat transfer system is described comprising a heat source in the path of the coolant and heat exchangers to transfer heat to a secondary fluid. Provisions for advantageous construction are included. The entire installation is inside a pressure vessel. Drawings and specifications are included. (J.R.D.)

15807 FUEL ELEMENT FOR A NUCLEAR REACTOR. (to United States Atomic Energy Commission). British Patent 1,056,732. Jan. 25, 1967. Priority date Apr. 20, 1964, United States.

Design of a heterogeneously enriched Pu-bearing fuel element is described in which the Pu is concentrated along the fuel element axis. The outer portion of the element contains natural UO_2. The element may be rejuvenated without reprocessing by inserting a new Pu–Zr wire in the central cavity. (J.R.D.)

15808 APPARATUS FOR CONTROLLING A NUCLEAR REACTOR BY ABSORBENT GAS AND DEVICE FOR ITS APPLICATION. Plante, Jacques (to Commissariat a l'Energie Atomique). British Patent 1,057,397. Feb. 1, 1967. Priority date Sept. 26, 1962, France.

Methods and apparatus for controlling reactors by variation of pressure of neutron-absorbent gas mixtures in the core or reflector are described. The gaseous mixture is included in the primary coolant stream. Drawings and specifications are included. (J.R.D.)

15809 APPARATUS FOR SORTING SPHERICAL BEADS. (to Brown Boveri/Krupp Reaktorbau GmbH). British Patent 1,057,527. Feb. 1, 1967. Priority date July 1, 1964, Germany.

An apparatus is described, designed to separate beads of a prescribed dia from beads having damaged surfaces or smaller dia. The design is specifically for sorting spherical fuel pellets. Specifications and drawings are included. (J.R.D.)

15810 FUEL ROD STRUCTURE. (to Atomic Energy of Canada). British Patent 1,056,905. Feb. 1, 1967. Priority date Aug. 28, 1964, Canada.

Design of a fuel assembly is described in which clad elements are in contact with each other at convex protuberances. Provisions are made for assembly, disassembly, and coolant flow. Improved wear and breakdown resistance are claimed for such fuel assemblies. (J.R.D.)

15811 CONTROL ELEMENTS FOR FAST NUCLEAR REACTORS. (to Hitachi Ltd.). British Patent 1,056,950. Feb. 1, 1967. Priority date Dec. 22, 1964, Japan.

Design of control elements comprising neutron moderator and absorber is described. The neutron absorber has a large neutron-absorption cross section in the intermediate neutron energy range in combination with a limited quantity of moderator material for slowing down fast neutrons produced in the fuel. Fast neutrons are thus moderated and absorbed. (J.R.D.)

15812 IMPROVEMENTS IN OR RELATING TO FUEL ASSEMBLIES FOR NUCLEAR REACTORS. Guild, James Carrie (to United Kingdom Atomic Energy Authority). British Patent 1,057,141. Feb. 1, 1967. Filed Jan. 9, 1963.

Design of a fuel assembly is described in which the elements are spaced in a cluster around a central pillar and in which a grid structure laterally locates the ends of the fuel elements and allows coolant passage along the elements. The assembly is oriented vertically in the core. Drawings and specifications are included. (J.R.D.)

GENERAL

15813 (ANL-7029) PHYSICS DIVISION SUMMARY REPORT, JANUARY-MARCH 1965. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 49p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Separate abstracts were prepared for each of the six sections presented. (B.G.D.)

For abstracts of individual sections see: 14174, 14420, 14421, 14942, 15412, and 15430.

15814 (BNWL-113-23) PLUTONIUM ABSTRACTS. Volume 6, Number 11. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 31, 1966. Contract AT(45-1)-1830. 74p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

138 references to journal articles and reports published from Feb. 1964 to Dec. 1966 which contain technical information on plutonium are presented. The subjects covered include biology and medicine, chemistry, health and safety, metallurgy and ceramics, physics, and metallurgy. (F.S.)

15815 (BNWL-280, pp 15-17) CONGENITAL NEONATAL ANEMIA IN HANFORD MINIATURE SWINE. Ragan, H. A.; Palotay, J. L.; Clarke, W. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

An apparent genetically related anemia has occurred in newborn Hanford miniature swine. This appears to be a macrocytic, hyperchromic anemia resulting from maturation arrest in precursors of the erythrocytic series. (auth)

15816 (BNWL-280, pp 78-9) CONTROL OF DENTAL CALCULUS IN EXPERIMENTAL BEAGLES. Brown, M. G.; Park, J. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Dental calculus was reduced in dogs when their normal soft diet was supplemented with one-half an oxtail weekly. Approximately 85% of the accumulated dental calculus was removed from the surface of the teeth after four oxtail feedings. Approximately 35% of the individual teeth of the dogs showed calculus deposits after the test period compared to 85% before oxtails were fed. (auth)

15817 (LA-DC-6813) AUTOMATIC LENS DESIGN BY NONLINEAR LEAST SQUARES, PRACTICE AND MALPRACTICE. Doyle, Thomas C. (Los Alamos Scientific Lab., N. Mex.). [1963]. Contract W-7405-eng-36. 95p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The merit of any trial lens system with continuously variable parameters $u \equiv (u^1, \ldots, u^n)$ may be evaluated by tracing sample rays to form the $N \geq n$ components E_A of an error vector E of squared magnitude $\phi \equiv E \cdot E$. Regarding the lens u as a point of arithmetic space A_n, the most general mapping m of n-dimensional A_n into N-dimensional Euclidean E_N is considered and the direction of steepest descent in A_n of ϕ relative to this general mapping m is defined. M is then restricted to be the orthonormal lens error mapping of A_n into E_N. The resulting least squares equations of steepest descent lead to a parameter increment vector $\Delta u \epsilon A_n$ such that $\phi(u + \Delta u) < \phi(u)$. Iteration generates a convergent monotone decreasing sequence $[\phi] \rightarrow \phi_L$ and its corresponding trial lens sequence $[u] \rightarrow u_L$, where u_L is the desired local optimum lens attainable by the process from the first trial lens. (auth)

15818 (NP-16531) OCCUPATIONAL SKILLS AND CIVIL DEFENSE. Brown, Stephen L. (Stanford Research Inst., Menlo Park, Calif.). Sept. 1966. Contract OCD-PS-64-201. 75p. CFSTI $3.00 cy, $0.65 mn.

Detailed knowledge of local distributions of industrial skills and nationwide patterns of employment is useful preattack in analyzing industrial vulnerability and postattack in allocating labor resources. A method for estimating occupation-industry distribution, by census tract, is proposed and used in a hypothetical attack on San Jose, California, to investigate selective survival of occupational skills. A matrix of occupations, by industry, is presented for the entire United States. The types of analyses that can be undertaken using the matrix are discussed. (auth)

15819 (ORNL-NSIC-30) COMPILATION OF UNITED STATES NUCLEAR STANDARDS. 3rd Edition, 1966. (Oak Ridge National Lab., Tenn.). Dec. 1966. Contract W-7405-eng-26. 111p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A compilation of all known standards and regulations applicable to the nuclear industry in the United States are presented in tabular form. Standards activities of all organizations including technical societies as well as relevant regulations established by government agencies are shown in alphabetical order. Brief descriptions of most organizations which developed the standards are also included. (F.S.)

15820 (TID-3739) BIBLIOGRAPHIES OF ATOMIC ENERGY LITERATURE. Issued or in Progress During the Period December 1966-January 1967. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Feb. 9, 1967. 11p. Dep. DTIE Free.

Seventy-five bibliographies issued and in preparation on atomic energy literature are listed along with a report number index. (B.G.D.)

15821 ANALYSIS AND AUTOMATED HANDLING OF TECHNICAL INFORMATION AT THE NSIC. Buchanan, J. R.; Hutton, F. C. Nucl. Safety, 8: 95-102(Winter 1966-1967). (ORNL-P-2263).

The Nuclear Safety Information Center serves the nuclear community by collecting, storing, evaluating, and disseminating safety information relevant to the design and operation of nuclear facilities. In 1964, after about a year of operation, the information-handling system was computerized in order to increase broadly the scope of the center's services and enable efficient functioning in the future. Computer programs were developed for a bibliography (issued quarterly), complete with key-word and personal-author indexes, and for the selective dissemination of information (SDI). The SDI program is produced on 5- by 8-in. cards. These programs and other services of the center are discussed. (auth)

15822 AEC DEVELOPMENTS IN MATERIALS MANAGEMENT. George, Douglas E. (Atomic Energy Commission, Washington, D. C.). pp 175-90 of Institute of Nuclear Materials Management Sixth Annual Meeting. Columbus, Ohio, Institute of Nuclear Materials Management, 1965.

Activities of the Division of Nuclear Materials Management of the AEC are described. These activities include: contracts for sale of nuclear materials and U enrichment services; foreign barter arrangements; guaranteed purchase prices for Pu and U-233; distribution of special nuclear materials to other Federal agencies; effects of private ownership legislation on existing contractual arrangements; and administrative overhead and costs of handling small quantities of nuclear materials, such as small Pu-Be sources. Modifications in the current regulations on export-import licenses, security controls, and accountability requirements are discussed. The current draft of Form AEC 101 nuclear materials transfer document which will replace Forms 101 and 388 is described. (F.S.)

15823 COMMENTS CONCERNING THE AEC SUPPLY AGREEMENT. Keller, Charles A. (Atomic Energy Commission, Oak Ridge, Tenn.). pp 63-72 of Institute of Nuclear Materials Management Sixth Annual Meeting. Columbus, Ohio, Institute of Nuclear Materials Management, 1965.

The Supply Agreement between the AEC and private industry under which the latter can secure and hold enriched U for use in processing or fabricating enriched U products for use under Commission contracts or subcontracts is discussed. As yet no problems have been met but among the possible problem areas are the following: the return of materials for credit, the necessity for keeping good records, the "Use Charge Credits," and the question as to whether processors and fabricators may bring under the Supply Agreement that material they already possess and are using to fulfill unit price contracts. (F.S.)

15824 INMM STANDARDS COMMITTEE REPORT. McDowell, S. C. T. (Atomic Energy Commission, Washington, D. C.). pp 143-56 of Institute of Nuclear Materials Management Sixth Annual Meeting. Columbus, Ohio, Institute of Nuclear Materials Management, 1965.

The activities of the following Institute of Nuclear Materials Management Committees were reviewed: Standards; SS Color Code; Glossary of Terms; Scrap Classification Guide; Fuels Standards; and Standards for Shipping Containers. (F.S.)

15825 PLANS FOR NEW YORK STATE. Anderson, Jon D. (New York State Office of Atomic and Space Development. New York State Atomic and Space Development Authority). pp 1-18 of Institute of Nuclear Materials Management Sixth Annual Meeting. Columbus, Ohio, Institute of Nuclear Materials Management, 1965.

The proper role of the State of New York in the field of atomic energy is discussed. The status of the following projects of the origianl plan are summarized: the Nine Mile Point 525,000 KW nuclear power station; port facilities to handle nuclear materials; radioisotope regulatory authority; strengthening atomic research and training in the higher education system; fostering the use of radioisotopes in industry; and the construction of a fuel reprocessing plant waste storage facility. New project plans include: the

Western New York Nuclear Service Center for waste burial; a Space Technology and Atomic Radiation Center; a sea water purification plant; and a nuclear shipyard with port facilities. (F.S.)

15826 STATUS OF PROPOSED CHANGES IN TRANSPORT REGULATIONS. Black, William F. (Association of American Railroads, New York). pp 57-62 of Institute of Nuclear Materials Management Sixth Annual Meeting. Columbus, Ohio, Institute of Nuclear Materials Management, 1965.

Proposed changes in the Interstate Commerce Commission Transport Regulations are discussed. Proposals made by the Bureau of Explosives, Association of American Railroads, which affect the shipment of fissile radioactive materials are discussed. The three classes of fissile material packages are described. Standardized shipping containers and the terms "reasonable safety" and "absolute safety" are explained. The shipping regulations will aid in assuring a high-level of public safety in the transportation of radioactive materials. (F.S.)

15827 NUCLEAR MATERIALS MANAGEMENT RELATIONS FUEL FABRICATOR AND REACTOR OPERATOR. Donovan, H. W. (General Electric Co., Cincinnati). pp 169-74 of Institute of Nuclear Materials Management Sixth Annual Meeting. Columbus, Ohio, Institute of Nuclear Materials Management, 1965.

The need for the development of accepted uranium measuring standards and practices for adoption on an industry-wide basis and which are capable of being audited in a manner similar to that practiced in other industries is discussed. Present inventory audit procedures of reactor operators and their financial responsibility in handling leased U are described. (F.S.)